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A Policy Analysis of Alternative Military Retirement Systems

Beth J. Asch, John T. Warner

National Defense Research Institute

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Prepared for the Office of the Secretary of Defense

National Defense Research Institute

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PREFACE

This report presents an empirical version of a theoretical model developed in a companion report (Asch and Warner, 1994). The research is intended to permit an analysis of the issues surrounding the question of how military compensation should be designed. It should be of interest to analysts concerned with the structuring of compensation in large hierarchical organizations, such as the military, as well as to compensation managers.

This research was conducted for the Undersecretary of Defense (Personnel and Readiness) within the Defense Manpower Research Center in RAND's National Defense Research Institute, a federally funded research and development center sponsored by the Office of the Secretary of Defense, the Joint Staff, and the defense agencies. John Warner is a professor of economics at Clemson University and a RAND consultant. During the course of this research, he worked as a visiting scholar in the Office of Special Projects and Research, Office of the Assistant Secretary of Defense (Force Management and Personnel).

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SUMMARY

A primary goal of military compensation is to enable the military to meet its manning goals for force size, composition, and wartime capability. To attain these objectives, compensation must be appropriately structured to attract, retain, and motivate personnel at a reasonable cost even when national security goals are changing. A key question facing military manpower and compensation managers is how military compensation should be structured. This question has been actively debated over the years. But past studies have narrowly focused on the relationship between compensation and retention. Less attention has been paid to whether the military compensation system induces the best individuals to stay and seek advancements and whether it motivates effective work.

To address the issue of how military compensation should be designed in light of these considerations, a model is needed. In a companion piece (Asch and Warner, 1994), we develop a model of compensation in a large, hierarchical organization like the military that permits an analysis of the issues surrounding the design of military compensation. In this report, we summarize the theoretical model, present an empirical version of that model, and use it to evaluate the current and alternative military retirement systems in terms of their implications for force structure, cost, and productivity. By productivity implications, we mean the capability of the systems to motivate personnel to work hard and effectively and to motivate higher ability personnel to stay and seek promotions to higher ranks, i.e., to sort ability.

Our empirical model is a computer simulation of our theoretical model. The simulation model builds upon the Gotz-McCall dynamic retention model (Gotz and McCall, 1984) and incorporates personnel ability and effort supply in each grade and year of service (YOS). In our model, personnel enter the hypothetical forces and flow through the system based on historical promotion rates. Individuals make retention and effort supply decisions based on their tastes, ability level, random shocks, and personnel and compensation policies. To develop this model we needed parameter values relating to individual retention decisions, to individual effort decisions, and to the relationship between ability and compensation. We calibrated some of these parameter values by using historical information on Army force structure and retention patterns and by using past estimates of the effect of military personnel aptitude on promotion probabilities. Because other parameter values were assumed, we conducted sensitivity analyses to determine the sensitivity of our results to our assumptions. Not only is our empirical model able to predict the Army's observed enlisted and officer forces, but the retention patterns it predicts in response to pay changes are consistent with previous econometric estimates.

We use the model to evaluate the force structure, the cost, and the productivity (i.e., personnel effort and ability sorting) implications of the current military compensation system and the implications of several proposals that change the structure of the military retirement system, including several of our own design. Numerous criticisms have been levied against the military retirement system, especially with regard to its vesting provision. The current system vests personnel who serve 20 years in an immediate annuity. Those who serve less than 20 years receive no retirement benefit.[1] One of the main criticisms of this system is that its delayed vesting provision is unfair to most military entrants since most do not serve a full 20 years.

One recent proposal—that of the Senate Armed Services Committee—would vest personnel earlier by providing "Band-Aid" vesting, i.e., by entitling pre–YOS 20 separatees to an old-age annu-

[1]The exception are those individuals who serve long enough in a reserve component to qualify for a reserve retirement benefit that begins at age 60.

ity. Our empirical model predicts that this system would have no apparent influence on voluntary retention patterns, effort supply, or ability sorting but would add significantly to retirement costs. To be a useful tool, Band-Aid vesting would have to influence force managers to modify personnel practices in ways that are unlikely given the continued availability of a sizable retirement benefit for those who retire at YOS 20.

A second way to provide earlier vesting is to reduce the YOS for an immediate annuity. We analyzed a retirement system that would vest at YOS 15 using our empirical model and estimated that this system would be both highly costly and inefficient. Although it improves enlisted retention, it has a perverse effect on officer retention. Furthermore, intergrade ability differentials generally fall, implying that higher ability personnel are less motivated to stay and seek advancement to the upper grades. Average effort supply also generally falls and total force costs rise by about $1 billion per year.

The options for earlier vesting are, therefore, not attractive without a move away from the system of immediate annuities for military retirees, a move that would eliminate the distinction between pre–YOS 20 and post–YOS 20 separation. The bulk of the cost of military retirement is the annuity paid to retirees during their "second-career" years or the years between the age when they retire from the military (usually some time in their 40s) and the age when they retire from the workforce (usually some time in their 60s). Some cost savings must come from this group if earlier vesting is to be affordable. We designed several systems that do this. Specifically, these systems provide YOS 10+ separatees an old-age annuity beginning at age 60 that is based on the standard formula for military retirement benefits and a cash separation payment.

We estimate with our model that under certain circumstances these systems would permit the Department of Defense (DoD) to maintain forces at least as capable as today's at no higher cost. These circumstances require that DoD raise active pay enough to counter the adverse retention effects arising from reduced retirement benefits for YOS 20+ retirees. Such systems have several advantages in addition to their cost advantage. The active pay increases that the systems permit would enable DoD to skew the active duty pay table so that intergrade pay differentials are even greater at higher grades. As a

result of increased skewness, we estimate a significant increase in personnel effort supply and the incentive of higher ability personnel to stay and to seek advancement. Very important is how such systems would modify personnel management. Although the effect is unmeasurable, a system that lessens the distinction between pre- and post-20 YOS separations would allow much more flexible force management across occupations and services. Such additional flexibility may yield significant savings from force restructuring that is consistent with a post-cold war national security environment.

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Chapter One

INTRODUCTION

In fiscal year (FY) 1990 total military compensation costs exceeded 45 billion dollars.[1] Given the size of these costs, it is no wonder that the adequacy and efficiency of military compensation have been topics of constant debate. These debates have become particularly active when changes have occurred in the military and the environment in which it operates. For example, the recent drawdown has raised the issue of whether the military compensation system, especially its retirement system, has hampered the Department of Defense's (DoD's) ability to reduce the size of its personnel force.

Past study groups and commissions have advanced numerous proposals to alter the military's compensation system. But to address questions about the appropriateness of the size and structure of the military system, a theory or model is needed that recognizes the military's manpower goals, incorporates the essential features of the military organization, and predicts the behavioral responses of personnel to alternative compensation and personnel policies. Unfortunately, past studies that have developed such models have narrowly focused on the relationship between compensation and retention behavior and the resulting experience structure of the force and have ignored the other consequences of the military's personnel and compensation system. In particular, less attention has been paid to questions of productivity and specifically the issues of (1) whether the system induces the most able personnel to stay and

[1]DoD (1991), p. 16.

seek advancement to the highest ranks and (2) whether the system encourages personnel to work hard and effectively.

In a companion piece to this report, we develop a theoretical model that allows an analysis of these issues.[2] This model permits an analysis of both the traditional macroeconomic issues addressed in past studies that relate to the force size/structure implications of alternative compensation designs and the microeconomic issues relating to effort supply and ability sorting that have been heretofore ignored. Our model weds a previously developed method of analyzing the relationship between military retention and compensation with the emerging literature in economics on how large hierarchical organizations use compensation and personnel policies to motivate work effort and induce the best ability sorting within the organization.

There are two types of models of retention behavior and compensation: the annualized cost of leaving (ACOL) model and the Gotz-McCall dynamic retention model (Gotz and McCall, 1984). In developing our model we use the Gotz-McCall approach. While the relative merits of the two approaches have been discussed at length elsewhere [see Warner (1981), Warner and Goldberg (1984), Arguden (1986), Black, Moffitt, and Warner (1990), and Gotz (1990)], perhaps the most important advantage of the Gotz-McCall model for the purposes of our work is that it allows us to investigate the force structure implications of policies that depart significantly from current policy. The ACOL model is better suited for examining the implications of marginal changes from current policy. In modeling effort supply and ability sorting in the military, we rely on the work of Lazear and Rosen (1981) and others in modeling promotion "contests."

In this report we develop an empirical version of our theoretical model. We then use it to evaluate the force structure, the cost, and the productivity (i.e., the effort and ability sorting) implications of the current and various alternative military retirement systems. Some of these alternatives are the proposed changes to the retirement system that have been recommended by past study groups. Other alternatives are ones of our own design and address some of

[2]See Asch and Warner (1994).

the concerns about the retirement system that have been highlighted because of the drawdown.

APPROACH

To empirically implement our theoretical model, we could have used two alternative approaches. One is to estimate the parameters of our model empirically using panel data on observed individual retention decisions and effort decisions over the course of an individual's career and then use the estimated model to forecast the effects of different policies. Such an approach is infeasible for two reasons. First, other than very recent work by Daula and Moffitt (1992), attempts to estimate just the retention portion of the model have not borne much fruit. Second, except for some spotty information on military personnel performance, data on effort decisions do not exist.

We therefore took the second and more parsimonious approach, namely computer simulation of our theoretical model. To build this microsimulation model, we needed three types of parameter values: those relating to individual retention decisions, to individual effort decisions, and to the relationship between ability and compensation. For the retention-related parameters, we note that the Gotz-McCall model is basically characterized by three parameters.[3] We experimented with alternative values of these parameters until the model replicated the historically observed aggregate retention patterns. To model personnel effort decisions empirically, we made assumptions about the relationships between effort supply and promotion and about the cost to individuals of supplying effort. We then conducted sensitivity analyses to determine whether the model's results were sensitive to changes in assumed parametric values. Finally, to implement empirically the ability sorting aspect of the model, we used data on military personnel aptitude scores, which are considered to be correlates of ability, as well as estimates made by previous studies of the effect of these scores on promotion probabilities.

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[3]These are the mean and standard deviation of the initial taste distribution and the standard deviation of the distribution of random shocks that each individual faces in each grade and year of service. Section 2 presents the model and highlights the role of these parameters in the model. See Asch and Warner (1994) for a more formal description.

EVALUATION OF THE RETIREMENT SYSTEM

We illustrate the use of our model by evaluating the military's retirement system. There are actually three retirement systems in effect as a result of modifications to the basic system in 1981 and 1988.[4] The basic structure remains the same, however. Individuals who separate with at least 20 years of service (YOS) receive an immediate lifetime annuity while those who separate with less than 20 YOS receive nothing (unless they serve long enough in a reserve component to qualify for a reserve retirement benefit that begins at age 60).

The basic system has been subject to numerous criticisms since it was implemented in the 1940s. Some of the most common criticisms are that the system is (1) excessively costly and unfair to taxpayers, (2) unfair to the vast majority of military entrants who do not serve long enough to receive retirement benefits, (3) inefficient, and (4) inflexible.

To the general public, the two most visible aspects of the system are its cost and the relatively young ages of military retirees. A noted defense analyst, Jacques Gansler, wrote that "The military retirement program, though politically loaded, is likely to be forced to change because of cost considerations." Gansler also wrote that "more and

[4]The three systems are structured as follows. Pre–FY 1981 entrants receive retired pay according to the formula .025*YOS*final basic pay (where YOS denotes years of service), such that 20-year retirees receive 50 percent of final basic pay and 30-year retirees receive 75 percent. Importantly, retired pay for this group is fully inflation-protected. Retired pay for those who entered between FY 1981 and FY 1986 is calculated similarly except that pay is based on the individual's high three years' average basic pay rather than final basic pay. It is also fully indexed for inflation.

The Military Retirement Reform Act of 1986, also known as REDUX, implemented several important changes. First, the annuity formula was changed to [.40 + .035*(YOS – 20)]*high-3 average basic pay for the years between separation and age 62, at which time pay reverts to .025*YOS*high-3 average basic pay. Consequently, retired pay during the transition between military service and full retirement ranges between 40 percent of high three years' average basic pay at YOS 20 and 75 percent of high three years' basic pay at YOS 30. Second, rather than indexing retired pay for inflation, the annual cost-of-living adjustment (COLA) between separation and age 62 is one percent less than the percentage growth in the Consumer Price Index (CPI). At age 62, retired pay is then fully adjusted for the CPI growth since separation. But thereafter it again increases according to the CPI minus one percent rule. The 1986 reforms thus changed the system by (1) reducing the amount received at YOS 20, (2) raising the growth in retired pay for each year served after YOS 20, and (3) reducing the real value of the stream of retired pay in an inflationary environment.

more people have been retiring at about 40 years of age, depriving the services of their expertise and collecting retired pay for the rest of their lives." The implication here is that retirees are departing before the services would like them to and are receiving "excessive" benefits at the expense of taxpayers.[5]

Other critics charge that it is unfair for 20-year separatees to receive a lifetime retirement annuity, while others who serve for shorter periods receive nothing. The fact that only about 30 to 40 percent of officer entrants and 10 to 15 percent of enlisted entrants will stay for a full 20-year career and receive benefits is seen to be unfair to those who receive no benefits for their service. The 1947 Joint Army-Navy Pay Board called the 20-year system a "tontine" after the Italian Lorenzo Tonti, who devised a contest in which participants each venture a sum with the winner being the one who lives the longest. A November 18, 1991, editorial in the *Navy Times* declared that "The unfairness of this system generally escapes the notice of anyone other than service people who, after serving honorably for 5, 10, or 15 years, leave the military with nothing but a handshake. The drawdown, however, is shedding more light on the inequity." The military, in fact, is one of the few organizations exempted from the Employee Retirement Income Security Act (ERISA), the federal law that requires private sector employers to vest employees in their retirement systems usually after YOS 5. Some have argued that the military should be brought under ERISA's early vesting requirements.

With regard to the efficiency of the system, critics have wondered why the military needs a retirement system at all. Since young people have high personal discount rates and ones that far exceed that of the government, retired pay could be reduced and retention incentives could be maintained with an active duty pay increase that was less than the present value of the savings to the government of reducing retired pay. Thus, the critics suggest that the same forces could be achieved at less cost. Some of these critics recognize the political infeasibility of eliminating the military retirement system and so support a far less generous one similar to the type mandated to the private sector by ERISA.

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[5]See Gansler (1989, pp. 297–298). Although Gansler wrote in 1989, the REDUX system implemented in August of 1986, in fact, substantially reduces benefits for those who separate at YOS 20, and it contains added incentives to serve beyond the 20-year mark.

Critics also charge that the military retirement system inhibits force management flexibility. The services are well aware of the financial costs imposed on mid-careerists who are involuntarily separated prior to the 20-year vesting point. As a result, beyond a certain grade or YOS, personnel are treated as if they have an implicit contract. The services are reluctant to separate all but the poorest performers for fear of what the effect of involuntary separations would be on morale. Because of these implicit contracts, the range of experience distributions that the services are willing to achieve is limited. That is, the services' "desired" force structures reflect the actual retention patterns that emerge as a result of the current compensation system. Without the constraint of the current retirement system, the "desired" force may differ significantly.

At this point, it must be recognized that the REDUX system implemented in 1986 significantly altered the structure of the retirement system.[6] These structural changes serve to mute some of the criticisms of the 20-year system. For one, they partially answer the criticism that the retirement system is too costly. REDUX has reduced DoD's annual accrual charge by over one-third compared with the pre-1980 system. For another, as we show in Chapter Five, REDUX provides a much stronger incentive to remain in service beyond the 20-year point. REDUX thus weakens Gansler's criticism that personnel are retiring at excessively "young" ages. By increasing the desire to stay after YOS 20, REDUX will give personnel managers more control over the flow of personnel and the selection for promotion beyond the 20-year mark. This added control will be most beneficial in the officer corps. As Chapter Five shows, REDUX will hurt pre-YOS 20 retention, but the decline will be modest and can be effectively managed by targeted pays like bonuses. By permitting the increased use of targeted pays, REDUX thus seems to provide personnel managers additional flexibility for managing the junior forces in various skills.

So if REDUX made such desirable changes to reduce the cost of the retirement system, to provide stronger post–20 year retention incentives, and to increase flexibilities in force management, why con-

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[6]REDUX covers all entrants on or after August 1, 1986, so it will not begin to affect retirement outlays until the year 2006.

template any further changes? The answer, we believe, is that REDUX does not in fact solve the basic force management difficulties associated with the 20-year system, and it may in fact reverse some desirable elements. Because it maintains 20-year vesting in an immediate annuity, it does not solve the implicit contract problem. REDUX will continue to "lock in" mid-careerists, and the services will still retain until the 20-year mark some personnel they would prefer to separate earlier. REDUX does not solve the difficulties that a common system poses for management of different career fields. Although its enhanced post–YOS 20 retention incentives are no doubt beneficial in many skill areas, such incentives may be detrimental in the "youth and vigor" skills. Superannuation may become a real problem in such skills.

In response to the various criticisms levied against the retirement system, numerous changes to the retirement system, including REDUX, have been proposed. In this report, we use our simulation model to examine the implications of several of these proposed changes in terms of not only their macroeconomic effect but also their microeconomic effect. To address the criticism that the system is too inflexible and unfair to pre–YOS 20 separatees, we also evaluate a proposal of our own design. Before presenting our simulation results, we summarize our theoretical model. In part, we present this discussion to provide a backdrop to the simulation results. In part, we present it to provide a response to the criticism that the military retirement system is unnecessary and should be drastically reduced.

The report is organized as follows. In Chapter Two, we present the overview of the theoretical model. In Chapter Three, we discuss some of the positive aspects of the retirement system in light of our model's theoretical implications and then discuss some of its drawbacks. In Chapter Four, we describe how we developed the computer simulation of our model and how we calibrated the model's parameters. We also discuss in this chapter how we estimated personnel compensation costs. In Chapter Five, we use the microsimulation model to evaluate the current and alternative military retirement systems in terms of their implications for retention and force structure, cost, effort supply, and ability sorting. Our conclusions are presented in Chapter Six.

Chapter Two

MODEL OVERVIEW

In this chapter we present an overview of our formal theoretical model to set the stage for our simulation results. We first list some of the military's primary manpower goals and then discuss our assumptions about individual productivity and ability in the military. Next, we describe our model of individual decisionmaking. Finally, we discuss the model's policy implications given our assumptions and analysis of individual decisions.

ORGANIZATIONAL GOALS AND OBJECTIVES

The military's universally stated manpower goal is to attract and retain personnel in sufficient numbers to meet its grade and experience requirements. We call this the "macro" goal. Not so well recognized are several "micro" goals. First, personnel must be motivated to work hard and effectively. Since individual effort cannot be directly observed cost-effectively, compensation and personnel policies must be designed to provide individuals with the proper incentives to work hard and seek advancement. Second, the system must sort personnel effectively. That is, it must induce the proper person/rank/job matches. This requires retaining and promoting the more able to the higher ranks. Several implications follow. One is that low ability/effort individuals should be induced to leave. Another is that "climbing" (seeking ranks for which one is unqualified) and "slumming" (the converse of climbing) should also be discouraged.

Furthermore, given their hierarchical rank structures, the services want personnel to stay long enough to get a return on their training

and experience, but not to stay too long. There must be enough turnover in the upper ranks to provide promotion opportunities for those in the lower ranks. Retention can be excessive, even among very able personnel. Consequently, the compensation system must be structured not only to provide the proper retention and effort incentives, but also to provide the incentive for personnel to separate when it is in the services' best interest for them to do so.

Military personnel managers have a variety of policy tools at their discretion. Compensation policy instruments include (1) the level of entry pay, (2) the sequencing of promotion and longevity increases thereafter (i.e., intergrade and intragrade pay spreads), (3) bonuses and other skill-specific pay, and (4) the retired pay system. Personnel policy levers include minimum standards for retention and promotion and use of up-or-out rules. How do individuals respond to these tools? We address this issue below, but first we discuss some of our assumptions about individual productivity.

INDIVIDUAL PRODUCTIVITY

It is clear from past research that military recruits vary with respect to both their ability to perform tasks within the military organization and their "tastes" for military life. Importantly, despite the substantial sums spent screening new recruits, the military cannot perfectly measure entrants' true abilities. Rather, ability is revealed slowly over time. Nor can individuals' tastes be observed. We can only discern from unfolding retention decisions that stayers have stronger tastes for service than nonstayers.

In addition to the difficulty of observing tastes and abilities, we assume that the military organization also has difficulty monitoring individuals' work efforts. Even though the military expends many resources monitoring work effort, it still cannot monitor effort directly or costlessly. Some people may work hard and effectively while others may not. Effort, of course, improves individual productivity, but it also involves a cost, namely hard work. We assume that individuals do not like to exert work effort and would prefer to shirk if they could get away with it. In other words, the marginal disutility of effort is positive.

We also assume that ability has a bigger impact on individual productivity or performance in the upper ranks than in the lower ranks. That is, a low mental-aptitude individual and a high mental-aptitude individual may perform low-level tasks equally well, but the high-aptitude person is likely to make a much better colonel or master sergeant than the person with low aptitude. Since higher-ranking personnel control more of the organization's resources and must make decisions that have greater overall impact, span-of-control considerations serve to magnify the importance of having the most able personnel fill the upper slots. Because of span-of-control considerations, individual work effort may also be more important at higher levels.

As Willis and Rosen (1979) discuss, a complicating factor is that ability is not unidimensional. Ability traits that are important for success in the lower ranks (e.g., physical strength or the capacity to follow orders) may not be the same as those required at the upper ranks (e.g., analytical reasoning or leadership skills). Skills that make one a good captain may not make one a good colonel. If this is the case, performance in the lower ranks may not be a good forecast of one's probable performance in the upper ranks, making selection for promotion that much more difficult. The problem is likely to be more severe in the officer ranks, and it leads the services to stretch out the selection of officers for the senior ranks over time.

INDIVIDUAL DECISIONMAKING

As indicated above, military personnel managers have a variety of policy tools at their disposal. The optimal policies will depend on individual decisionmaking. Once we understand how people behave and what factors influence them, policymakers can design policies to influence behavior according to the organization's goals.

Why do individuals join the military? Stay in the military? We hypothesize that individuals join if they are better off doing so (in economic terms, if the expected utility from joining exceeds the expected utility from remaining in the civilian sector). The net payoff to joining depends partly on how long the individual remains in the military. Some join only for one tour, others for a 20-year career. We thus hypothesize that when deciding whether to join, individuals evaluate the payoffs to all the possible career paths that they might

follow and weight each path by the probability that they will follow it. Career paths are dimensioned by rank and YOS. Low-taste individuals anticipate that they will not be very likely to reenlist after an initial term. In contrast, individuals with stronger tastes for military life expect to serve for longer careers, so they will place more weight on the payoffs associated with longer careers (e.g., retirement benefits). The benefits provided during the initial enlistment will dominate to a greater extent the enlistment decisions of low-taste personnel.

Aside from tastes, the decision to join obviously depends in large part on the level of entry pay and its subsequent growth, both with respect to rank and longevity. Other important factors in the initial enlistment decision include the value of training received (and especially its transferability to the civilian market) and educational benefits. An implication of our model is that aptitude or ability has an ambiguous influence on the decision to join. To the extent that the more able have a higher expected payoff to joining (through, say, more rapid or more certain promotion or qualification for better educational benefits), they will be more likely to enlist. But the more able also have better civilian sector opportunities, which make them less likely to join.

The decision to remain at each retention decision point thereafter is conceptually similar to the initial enlistment decision. Individuals are assumed to calculate the expected utility from remaining in service by evaluating the payoffs to all possible future career paths and weighting the various paths by their probabilities. They will compare this utility with the utility from leaving immediately and stay if they expect to be better off. Again, we predict that high-taste individuals are more likely to stay. But more-able people may be more or less likely to stay than less-able people, depending on how ability is rewarded in the external market relative to the "internal" market. The internal reward to ability depends in part on the extent to which the promotion system identifies and promotes the more able more rapidly and with higher probability. Even prior to the actual separation point, up-or-out rules serve to induce separations of some personnel who know that they are likely to be affected by such rules.

Another factor that plays a role in retention decisions is the rate at which personnel discount future income. Past research indicates that personnel have real discount rates in excess of 10 percent, which

evidence from the drawdown separation program seems to confirm.[1] In our model, high discount rates serve to reduce the value of future pay relative to current pay and, therefore, cause individuals to place more weight on near-term pay in both their effort and retention decisions.

In addition to making retention decisions, personnel make choices about how hard to work. Individuals in the model supply effort in each grade and year of service up to the point where the extra (marginal) benefit of doing so equals the extra (marginal) cost. What factors affect effort? The answer is any factor that affects the marginal return or cost of effort. First and foremost in the military system is the return to promotion. Promotion to a higher rank provides a monetary reward, and it may also yield psychic benefits. To the extent that future promotions depend on current performance, we predict that a higher monetary reward to future promotions should induce individuals to work harder in their current rank. The model also predicts that individuals will work harder in their current rank the more they value the status associated with higher rank. Importantly, monetary rewards can come either through the active duty pay associated with higher rank or in the form of retirement benefits. Finally, individuals may also work harder in their current rank if there is an intragrade payoff that is contingent on effort. Performance bonuses or other nonmonetary rewards to top performers are hypothesized to spur effort.

The military's hierarchical rank structure and the structure of its promotion contests are predicted to affect effort in important ways. Subject to individual qualifications, personnel are promoted through the lower ranks with virtual certainty based on time-in-grade or time-in-service requirements. But beyond the junior ranks promotions are determined in competitive "contests" or "tournaments" in

[1]The vast majority of personnel are choosing lump-sum separation payments in lieu of annuities. The real discount rate that equates the present values of these options is around 13 percent. However, other aspects of the options offered in FY 1992 favor the choice of lump-sum separation payments. These differences were eliminated beginning in FY 1993, and it remains to be seen whether high discount rates or other factors explain the choice of separation payment.

which only a fraction of those seeking advancement are promoted.[2] The competition at the upper ranks gets keener because of the declining fraction to be promoted and the increasing homogeneity of the pool of contestants.[3]

Some theoretical propositions follow. If the interrank pay spread is held constant, a declining probability of promotion tends to diminish work effort because personnel discount the reward to promotion by the probability that the reward will be received. If the probability of promotion is low, individuals will not expend much effort to be promoted without a sufficient reward for promotion. Therefore, to maintain effort incentives with declining promotion rates, increasing interrank pay differentials are required.

The rate at which promotion chances improve with effort is also predicted to affect effort. Individuals are likely to work harder when extra effort improves their promotion chances a lot than when it improves them only a little. The rate at which effort improves the likelihood of promotion depends, in turn, on the relative importance of random factors ("noise" or "luck") in the promotion contest. Because promotion in the lower ranks is based on explicit criteria or standards, luck has only a small influence on promotion outcomes in the lower ranks. Luck assumes a larger role as individuals progress through the upper ranks. Having the "right" assignment, working for the "right" mentor, etc. loom larger in the promotion outcomes at higher levels. The increasingly more important role of luck serves to blunt the relationship between effort and the likelihood of promotion and thereby discourages effort as individuals progress through the ranks, all else equal.

The relationship between effort and the likelihood of promotion is also related to the composition of the promotion pool. In the lower

[2]Officer and enlisted promotion processes do differ somewhat. Officers are chosen for promotion by selection boards and are promoted by entry year group. Failure to be selected within a specified YOS zone usually means the officer will never be promoted. Prior to the two highest grades, enlisted personnel are promoted on the basis of point systems and may accumulate the points required for promotion over a wide YOS range.

[3]Historically, the promotion rates to O-4, O-5, and O-6 have been around 80 percent, 70 percent, and 50 percent, respectively. Promotion rates to these ranks have declined considerably during the drawdown.

ranks, there is likely to be a lot of variation, or heterogeneity, in the skills and qualifications of those available for promotion. When the promotion pool is heterogeneous, it is easy for an individual to bypass some of the others by working harder. As individuals progress through the ranks, the pool available for promotion to the next rank becomes more homogeneous because of the selection that has previously occurred. Bypassing one's competitors by working harder becomes increasingly difficult the more alike the individuals in the promotion pool. The increasing homogeneity of the individuals in the promotion pool is predicted to further blunt the relationship between effort and the likelihood of promotion.

Tastes and personal discount rates are also predicted to influence effort in the model. High-taste individuals are more likely to stay for future periods and are thus more likely to reap the benefits of harder work today. Therefore, high-taste individuals will work harder.[4] An important policy implication follows. Since first-termers have lower tastes than careerists on average, a pay raise targeted at the first-term force will not produce as much extra effort as a raise targeted at the career force. This result provides some rationale for skewing the pay table by longevity as well as by rank.

Finally, up-or-out rules are also hypothesized to induce effort by lowering the expected payoff to remaining in a lower grade (relative to advancement to a higher rank). Up-or-out rules, therefore, can serve as a substitute for a direct increase in interrank pay spreads.

ORGANIZATIONAL POLICIES TO MEET ORGANIZATIONAL GOALS

Organizational goals and policy tools have already been identified. We now discuss the policy implications of our analysis of individual decisionmaking, beginning with a discussion of entry-level (or first-term) pay.

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[4]Draft armies are difficult to motivate. The analysis here makes clear why. Contingent compensation cannot be used to motivate personnel who are not going to stay around long enough to collect it. Draft armies must be motivated by penalties associated with failure to perform (e.g., imprisonment and bad conduct discharges) rather than the promise of positive rewards for good performance.

Entry Pay

Since about two-thirds of enlistees remain for only one enlistment, their enlistment decisions will be based mostly on entry-level pay. The lack of lateral entry means that the military must access enough personnel at the entry level to fill lower-level positions today and higher-level positions in the future. Since ability is assumed to have an increasing effect on performance as individuals progress through the ranks, there must be a sufficient number of high-ability personnel in the entry cohort to fill the upper-level positions in the future. But the military cannot just selectively recruit sufficient numbers of high-ability personnel because true ability is unobservable at entry. However, when entry pay is increased, the ability mix improves because higher entry pay attracts more applicants who have observable characteristics that are correlated with ability (education level and test scores), and the military can and does, in fact, screen on these characteristics.

Our model predicts that the lack of lateral entry serves to raise the required level of entry pay. If new entrants were required to perform only low-level tasks and were not needed to advance to the upper ranks, a less-talented cohort of entrants could ably perform the lower-level tasks, which a lower-entry pay level would suffice to attract. Because of the requirement to raise entry pay to attract a cohort of more-talented entrants, many entrants are effectively overpaid because of the lack of lateral entry. (In the economist's jargon, they earn "economic rents" or payments in excess of their next-best alternatives.)

Related to the higher level of entry pay is the implication that the military must employ (proportionately) more people than would a civilian sector employer that has a similar number of high-level positions but also permits lateral entry, in order to identify those with the talent to advance. The larger proportionate size of the entry cohort creates a "buffer stock" that enables the military to ensure against talent shortfalls in the upper ranks. As we discuss below, these results have important implications for the design of the retirement system.

Two other factors serve to influence the level of entry pay. First is the (positive or negative) value that potential entrants place on the non-

pecuniary factors associated with military life. Entry pay will have to be higher the lower the mean taste is for military life among prospective entrants. The mean taste for service will, in turn, be related to youths' perceptions of such factors as the prestige associated with military service, in-service living conditions, and the risk of death or injury. The recruiting experiences of the all-volunteer force (AVF) period indicate that youths' perceptions of these factors have varied considerably over time and circumstance.

The second factor is the degree of transferability of military-acquired job skills. The less transferable the skills acquired during the initial enlistment, the less willing potential recruits will be to join and the higher will be the entry pay necessary to provide the incentive to enlist. For example, the Army has paid sizable bonuses and educational benefits to enlistees in the Combat Arms skills, which are nontransferable, but it does not need to pay bonuses or educational benefits to personnel receiving training in skills such as electronics and maintenance because they are more readily transferred to the civilian sector. Higher bonuses and educational benefits for the Combat Arms may also be due to more arduous conditions of service and the large requirements relative to supply of potential recruits. Such is clearly the case in the Navy, where enlistees into the Nuclear Power skills, who receive highly transferable training but must serve aboard submarines, are paid very large bonuses.

Sequencing Intergrade and Intragrade Pay

Consider now the model's implications for how pay should be sequenced by grade and longevity. Because promotions through the junior ranks occur with virtual certainty based on skill acquisition and satisfaction of time-in-grade (TIG) and time-in-service (TIS) requirements, intergrade increases do not need to be large in order to motivate effort. The mean enlisted grade at the end of the initial enlistment is E-4 and the mean officer grade is O-3. Over the initial enlistment, basic pay growth for enlisted personnel in the 1992 active duty basic pay table is 38 percent (E-1 under 4 months to E-4 over YOS 3). Comparable growth for officers is 57 percent (O-1 under 4 months to O-3 over YOS 3). Such growth is at least as much as pay growth at comparable ages and experience levels in civilian sector jobs.

Consider now the structure of pay beyond the junior ranks. Personnel begin to reach the middle ranks in the second term of service. It is here that promotions start to resemble a "tournament" with winners (promotees) and losers (nonpromotees). The military's objective is to sharpen the competition and to induce the most qualified to reveal themselves in the promotion contest. Among other policies, sharper competition is induced through bigger intergrade pay spreads. Larger intergrade spreads motivate harder work in the quest for advancement and therefore discourage slumming. Importantly, larger spreads encourage the more able to remain in service and therefore help maintain the quality of the promotion pool. And by improving the talent pool and by inducing the more able to work harder, larger intergrade spreads prevent "climbing" (promotions of the less qualified).

As individuals progress toward the senior ranks, promotion rates fall. Absent any change in the structure of pay, declining promotion rates tend to discourage effort. Clearly, interrank pay spreads need to rise with rank—i.e., be skewed—to maintain effort. The tendency to reduce effort is accentuated by several other factors. Two mentioned previously are the rising relative importance of "luck" in promotion outcomes and the increasing homogeneity of the promotion pool. Another is that as personnel progress through the ranks the number of remaining promotions (and therefore promotion payoffs) that can be earned falls. Skewness is required for personnel to see a continuing reward to effort.

A final factor that leads to increased skewness is the fact that the number of participants in the promotion contest declines as individuals progress through the ranks. We show elsewhere (Asch and Warner, 1994) that the marginal value of effort is smaller in contests that have fewer participants because in small contests people can pass fewer competitors by working harder. Since the scale of the contest diminishes at higher ranks, the interrank spreads should increase to maintain effort incentives.[5]

[5]Notice, though, that in the military there is still a sizable pool of competitors for promotion to the highest ranks, so pay spreads need not be as large here to motivate effort as in the top levels of corporations, which may have only a handful of competitors for promotion.

Other factors, though, reduce the required skewness. Obviously, the more value that individuals attach to the status and other nonpecuniaries associated with higher ranks, the smaller the additional monetary rewards needed to motivate effort in the lower ranks. These nonpecuniary factors tend to rise with grade. A second factor is the transferability of training. The less that training received in service improves outside employment opportunities, the smaller the in-service pay increases will need to be to maintain a given level of retention. The third factor is the correlation between tastes and ability. If the correlation is positive, so that the personnel who have stronger tastes are also the more able, then less skewness is required to induce the more able to stay and seek the higher ranks.

An oft-cited factor that reduces the optimal degree of skewness is that the production of military "output" is team oriented. Rosen (1992, pp. 234–235) writes that "if rewards are skewed too much, competitors may take steps to make others look bad rather than making themselves look good. Lack of cooperation and reduced cohesiveness can reduce the effectiveness of the overall team. Some happy medium must be struck here." In our opinion, this argument is not particularly compelling in the military case because of the sheer number of individuals participating in the promotion contests, the contestants' geographic dispersion (sabotage is more likely when people work together), and the tendency of performance evaluations to focus on team performance. In fact, concerns about military pay spreads usually have more to do with horizontal equity than vertical equity. Some critics believe that interoccupational pay variations arising from bonuses and the like erode cooperation and esprit de corps. Whether interoccupational pay spreads have any effect on morale is an unresolved question. Note, though, that several foreign militaries, including the United Kingdom's, have well-institutionalized systems of "skill pay," with no apparent detrimental effects.

Intragrade pay should function like intergrade pay to motivate effort and induce the proper sorting within the organization. Intragrade pay should rise to some extent with experience in order to provide continuing skill acquisition and performance incentives (at least when coupled with minimum performance standards for retention). However, the intrarank longevity increases cannot be as large as the interrank increases or individuals will be encouraged to "slum." And at some point intrarank longevity increases should cease altogether

so that those who are revealed to be unpromotable will be induced to leave voluntarily when it is in the services' interest that they do so. The *Report of the Seventh Quadrennial Review of Military Compensation* (DoD, 1992) has in fact identified and recommended correction of a number of inconsistencies between intrarank and interrank pay.

Finally, personnel policies like up-or-out rules and minimum performance standards can play a positive role by (1) increasing effort and (2) inducing the voluntary departure of those who have low promotion chances. The extra turnover induced by up-or-out rules helps maintain promotion flows.

Retired Pay

What are the purposes of retired pay? Does retired pay have a unique role that cannot be accomplished with other forms of compensation or other policy tools? We find that the purpose of military retired pay is much different from the purpose of retired pay in the civilian sector. Civilian sector firms are generally not bound by the military's lateral entry constraint. Because their workers can be hired directly into positions to perform similar tasks year after year, civilian firms are not as concerned with generating turnover of older employees to create advancement opportunities for new hires. As a result, for civilian firms retired pay is less a tool for managing personnel flows and providing work effort incentives and more a vehicle for providing workers with tax-sheltered savings opportunities. In fact, to the extent that the retirement benefits provided by civilian employers are offset by lower wages, retired pay need not affect the civilian employer's hiring or retention decisions (Lazear, 1988 and 1990).

The lateral entry constraint places the military in a much different situation. It must access and train large numbers of entrants before identifying for advancement those who have the talent to perform the higher-level tasks in the organization. It therefore wants to provide incentives for the most talented to stay and seek advancement and for others to leave after they discover that they are unsuitable for the upper level positions. That is, it must provide the proper incentives for personnel to self-sort. Salop and Salop (1976) were the first to recognize the use of "two-part" compensation schemes as a self-selection device. One such two-part scheme is a system of (1) active

pay and (2) deferred, retirement benefits that are paid only to those who achieve a certain rank and longevity. Delayed vesting of retired pay induces self-sorting because only those who think that they can achieve the requisite rank and longevity will decide to stay early on while others will leave. Deferred retired pay is also predicted to motivate work effort, especially when combined with minimum performance standards for retention and up-or-out rules that prevent low-ranking personnel from staying long enough to collect retirement benefits.

This discussion of course begs the question of when vesting should occur. But notice that there is a trade-off between the vesting date and the organization's ability to pay new entrants. If the organization is to meet a fixed budget constraint, earlier vesting will dissipate its capacity to raise entry pay and attract a higher-quality entry cohort. Contrary to critics of delayed vesting, it is not necessarily unfair to the bulk of entrants who never qualify for retirement benefits because they are generally overpaid as a result of the lateral entry constraint.

The question now arises why retirement benefits should be part of the self-sorting mechanism. After all, why not just pay a bonus to all who reach the requisite rank and YOS? The answer has to do with retired pay's role as a separation incentive. At some point the military wants everyone, including the best personnel, to separate, even when they may still be individually very productive (i.e., their own productivity exceeds their pay). The longer individuals remain in the top positions, the slower the promotion rates for younger (and potentially equally able) personnel. Unless offset by changes in the structure of pay, reduced promotion opportunities in the junior ranks is predicted to discourage work effort in those ranks and will cause those junior personnel with the best external opportunities (i.e., the more able) to leave. Without the proper inducement, the senior personnel may not want to leave voluntarily if their military pay exceeds their best private-sector alternatives. Such is especially likely to be the case for those trained in the military-specific skills.

Retired pay can be used to induce voluntary separations of senior personnel. For example, once personnel become vested in the immediate annuities provided by the current retirement system, they have a much reduced gain from staying and are therefore more will-

ing to depart voluntarily.[6] The retirement system, therefore, induces the separations needed to control the age or experience structure of the force and to maintain promotion flows for younger personnel. The 1948 Hook Commission, in fact, understood this when it wrote that

> a sound retirement system is essential to solving the superannuation problem. The services must be kept young, vigorous, and efficient; a sound retirement plan with a proper compulsory retirement age will permit youth and brains to rise to the top in time to be effective. . . . This vitalization purpose is not new; it was the fundamental premise of the present retirement system when it was established 80 years ago. Other concepts of fair treatment and the traditional concepts of retirement for those taking up the profession of arms are also important and have been given consideration but the Commission does not consider them to be controlling.[7]

It is apparent from this statement that military retired pay is not "retired" pay in the conventional meaning of the term. It is not, for instance, a convenient vehicle for transferring consumption from the present to the future. Rather, the quotation makes clear the system's role in managing the desired age structure of the force.

There is, of course, no reason why the separations required to maintain personnel flows could not be accomplished with other policy tools, like up-or-out rules. In fact, during the drawdown period, mandatory separations have increased substantially with the reduction of high-year-of-tenure points. However, excessive reliance on involuntary separation to control the experience structure of the force can be bad for morale, impacting on recruiting, retention, and work effort. These adverse effects might require the payment of a "regret premium" to compensate for the prospect of involuntary separation. In addition, personnel faced with the prospect of involuntary separation are likely to engage in activities aimed at getting

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[6]Because their gain in staying is smaller, turnover of enlisted personnel at YOS 20 is much higher than officer turnover. Most enlisted personnel have reached their terminal grades by YOS 20 and have fewer promotions and smaller in-grade longevity raises to look forward to. Beyond the 20-year mark, officers appear to postpone their separations until they fail selection to the next rank.

[7]See the Hook Commission report (U.S. Government Printing Office, 1948, p. 40).

the policy relaxed (e.g., complaining to the personnel managers and writing to congressmen about the "unfairness" of the policy). Should their complaints prove successful, the services would be compelled to modify their forces in unproductive ways. After Milgrom (1988), we call these extra financial costs and productivity effects the "organizational influence costs" of mandatory separation. The organizational influence costs of the drawdown are apparent today. There is presently much discontent in the mid-ranks over the likelihood of mandatory separation. Separation pay is the "elixir" that eases termination from service, and it weakens potential criticisms about the capriciousness or arbitrariness of policy.

As mentioned in the introduction, critics of the current retirement system have charged that efficiency would be increased if the military shifted compensation away from retired pay and toward active duty pay. However, such a policy would necessitate heavier reliance on involuntary separation policy to control the experience distribution of the force. Pressure would develop on the services to relax their policies and permit older personnel to stay until full retirement, and superannuated forces might result.[8] The adverse productivity effects of a much older force or the regret premium that might be required to maintain the current (younger) experience distribution, while hard to calculate, could be substantial. While clearly expensive, a system that provides voluntary separation incentives is likely to be cheaper.

The other purposes of retired pay are, of course, not unique. Motivating effort, improving retention, and inducing personnel to properly self-sort within the organization could be accomplished through an appropriately structured active duty pay table and through other personnel policies. So if there is a distinctive (if not

[8]Data from the reserves provide evidence that, in the absence of separation incentives, personnel would want to remain for much longer careers. Although vested after 20 creditable years of reserve service, reservists do not begin to receive any benefits until age 60. Compared with the active force, retention of reservists with 20 or more years of service is much higher. There is presently some concern about superannuation in the reserve forces.

unique) purpose for military retired pay, inducing voluntary separations at the appropriate points (thereby minimizing the influence costs that accompany involuntary separation) must be it.

Chapter Three

RETIREMENT SYSTEM ISSUES

This chapter applies the concepts introduced in the previous chapter to the current retirement system. We highlight the positive aspects of the current system and then some of its drawbacks. The next chapter then evaluates the current system and several of the various proposals made for retirement reform in terms of their implications for force structure, productivity, and cost.

The retirement system, in fact, embodies many of the features one would expect in the compensation system of a hierarchical organization. First, our theory predicts that hierarchical organizations will delay retirement vesting because of the sorting effects that are created and because delayed vesting provides the resources to raise entry-level pay and attract a higher-quality entry pool. The current system certainly delays vesting. Second, the delayed benefits effectively skew total compensation toward those capable of reaching the upper ranks, thereby maintaining the motivation and work effort of nonvested personnel.[1] Finally, the generous nature of the benefits for those who become vested induces voluntary separations and helps minimize the organizational influence costs that might attend the separation of senior personnel under less generous terms.

But as we noted in the introduction, despite these virtues the system is not immune to criticism. We begin by discussing force manage-

[1]Under Defense Officer Personnel Management Act (DOPMA) rules, officers in the ranks of O-4 and above may complete a 20-year career; O-3s and below must separate earlier. The services' policies governing enlisted personnel vary. The Army and Marine Corps now separate personnel in the grades E-5 and below prior to the 20-year mark, but the Navy and Air Force permit E-5s to complete a 20-year career.

ment issues. The basic criticism of the 20-year system regards the force structure that it produces. Table 1 presents some summary statistics on the experience distribution of the force at the end of FY 1990.

At a very general level, the retirement system creates the implicit contract problem mentioned in Chapter One. The prospect of 20-year retirement is a delayed "carrot" that induces personnel to invest in military-specific job skills, to accept onerous or hazardous assignments, and generally to exert work effort early in their careers. Individuals, of course, will not make such investments without a good chance that the investments will pay off. Therefore, beyond a certain career point, involuntary separations would appear capricious and would adversely affect the incentive scheme. The services are understandably reluctant to separate mid-career personnel for fear of how such separations will affect the behavior of more-junior personnel. The 20-year system creates a kind of guarantee of tenure to mid-careerists and, arguably, has the effect of inducing the services to "demand" more mid-careerists than they might under a different system. Thus, the "desired" force structures become largely based on what can be supported with the retention patterns produced by the compensation system and not necessarily force structures the services would choose without the constraints imposed by the current retirement system.

Table 1

YOS Distribution of U.S. Armed Forces, FY 1990 (in percentage)

YOS	Army	Navy	Air Force	Marine Corps
		Enlisthed		
0–4	50.2	49.9	35.8	59.3
5–10	26.3	27.2	31.3	23.4
11–20	21.2	20.3	27.6	15.3
21–30	2.3	2.7	5.3	1.8
		Officers		
0–5	35.6	45.7	30.4	37.5
6–11	29.5	26.7	34.4	26.5
12–20	25.1	19.5	25.3	28.2
21–30	9.8	7.3	9.2	7.5

That the terms of separation affect force management practices is illustrated by the Army's Qualitative Management Program (QMP). Under QMP, a board of senior enlisted personnel meets annually to select for involuntary separation about 2 to 3 percent of the lowest performers in grades E-5 through E-9. But the board selects for separation only those who are retirement eligible! That is, recognizing the financial costs imposed on those who have not yet qualified for retirement benefits, it selects for separation only those who would not be excessively financially penalized by involuntary separation. It is likely that all of the services have carried to the 20-year point many personnel who would have been separated earlier under a different system. Anecdotal evidence suggests that the Voluntary Separation Incentive (VSI) and Selective Separation Benefit (SSB) programs are inducing precisely the right people—underperformers and those with poor future promotion prospects—to leave.

Retention trends during the AVF era have compounded the implicit contracting problem. Higher first-term retention during the AVF meant larger flows into the career force, more personnel competing for promotion to the upper ranks, and more difficulty in meeting grade table limits. The implicit contract to mid-careerists limited the services' ability to control flows of mid-career personnel and reduced promotion opportunities for the younger personnel. Overall, the fraction of the enlisted forces with more than 10 YOS rose by about 25 percent over the 1974–1989 period, with the largest seniority increases in the Army (43 percent) and the Marine Corps (49 percent). In fact, the Navy and Air Force experienced little increase in the fractions of their enlisted forces with more than 10 YOS.

While increased enlisted seniority might theoretically be welcomed on the ground that more-experienced forces are more productive, it is important to note that the seniority growth occurred in the two services that profess the most need for youth and vigor in their enlisted forces. The seniority growth raised serious questions about cost and made evident the services' inability to effectively manage their senior enlisted forces. After considerable pressure from the Office of the Secretary of Defense, in 1990 the services did begin applying more stringent high year-of-tenure rules to their enlisted forces. But these more stringent rules affected relatively few personnel who were not retirement eligible. It was the large force reductions that began after 1990 that forced the services to seriously con-

sider separating significant numbers of mid-career personnel. At first, the services wanted to reduce their strengths by cutting accessions, but the implications of this policy for the future force structure soon became clear. It was only after the implementation of the VSI and SSB schemes that the services agreed to reductions in the mid-career force. These separation payment schemes are temporary, expiring in 1995, but the experience with them so far illustrates how force management practices would change with different terms of separation.

A related point is that when the quality of entering cohorts varies substantially, the retirement system compounds the difficulty of managing quality flows through the force. Cohorts entering the Army in the late 1970s were of poorer quality than later cohorts. High retention of these cohorts as they entered their second decade of service clogged the mid-ranks and increased the difficulty of retaining and advancing the higher-aptitude personnel in the later cohorts. The separation tools offered by the drawdown program have enabled the Army to selectively separate the less able personnel, again something it would not have done without them.

The 20-year system poses difficulties at more-detailed levels. The system is identical for all (active) members regardless of occupation or service and regardless of whether the individual is an officer or a member of the enlisted force. Yet, occupations, services, and officer and enlisted roles are obviously different. One important way that occupations differ is in their desired experience profiles. In some occupations, notably combat arms skills, a youthful experience profile is required. In others, not only are youth and vigor not primary job requirements, but large training costs and/or a big payoff to job experience (such as for doctors and nurses) argue for longer than 20-year military careers. But as Table 2 illustrates for enlisted personnel, the system produces similar force profiles across the broad spectrum of occupations. Thus, force managers seem to have little flexibility in shaping or controlling the experience profiles of different occupations (or services).

Because of the numerous criticisms levied against the system, a variety of proposals have been made to alter it. In Chapter Five, we evaluate several of the more recent proposals, including several of our own design.

Table 2

YOS Distribution and Percentage Distribution by DoD Occupation Group: Enlisted Forces, FY 1990 (in percentage)

Service	1-Digit Occupation Group[a]	YOS 0–4	YOS 5–10	YOS 11–20	YOS 21–30	Percentage of Total
Army	0	49.2	23.1	25.7	2.1	29.1
	1	46.8	28.3	23.5	1.4	4.4
	2	50.5	29.3	19.2	1.0	13.0
	3	45.4	29.1	24.2	1.4	6.6
	4	39.7	30.3	28.6	1.5	2.7
	5	30.9	29.2	33.2	6.7	16.4
	6	47.2	33.1	18.6	1.1	14.8
	7	49.6	30.8	18.6	0.9	2.0
	8	47.5	31.4	19.6	1.5	11.2
Navy	0	58.5	22.0	17.3	2.3	10.6
	1	45.0	31.3	21.3	2.4	17.9
	2	41.7	32.6	23.4	2.5	11.4
	3	43.5	30.6	22.8	3.1	6.7
	4	32.7	29.3	32.8	5.3	1.0
	5	31.2	31.7	32.8	4.3	10.9
	6	39.1	33.2	25.1	2.6	29.4
	7	37.2	31.8	28.5	2.6	6.5
	8	41.6	26.3	26.3	5.8	5.7
Air Force	0	33.1	36.3	27.2	3.3	7.2
	1	24.5	33.4	35.2	6.9	12.8
	2	26.9	33.7	33.7	5.6	6.6
	3	38.6	34.1	23.4	3.8	6.7
	4	30.2	33.5	30.5	5.7	4.0
	5	22.3	33.4	36.2	8.1	23.3
	6	27.9	34.6	33.7	3.7	24.2
	7	31.8	29.5	32.6	6.0	5.6
	8	37.1	31.5	27.1	4.4	9.5
Marine Corps	0	68.5	21.1	9.5	0.8	28.9
	1	38.8	33.1	25.4	2.7	7.6
	2	52.6	26.5	18.7	2.2	8.5
	4	44.0	28.6	23.9	3.5	2.3
	5	40.5	28.5	25.5	5.6	17.1
	6	47.8	29.0	21.2	2.1	18.4
	7	54.1	27.2	17.6	1.1	3.0
	8	56.4	25.8	16.5	1.3	14.2

[a]Group designations are: 0 = Infantry, Gun Crews, and Seamanship Specialists; 1 = Electronic Equipment Repairers; 2 = Communications and Intelligence Specialists; 3 = Health Care Specialists; 4 = Other Technical and Allied Specialists; 5 = Administration and Functional Support; 6 = Electrical/Mechanical Equipment Repairers; 7 = Craftsmen; 8 = Service and Supply Handlers.

Chapter Four

MODEL CALIBRATION

Our goal is to develop an empirical version of our theoretical model that (1) predicts the steady-state grade-by-YOS distribution of both the enlisted and officer forces under different policy regimes; (2) calculates the costs of those forces; and (3) estimates how our productivity measures, namely average effort and ability sorting, change under alternative policies. This empirical analysis is based on a computer simulation of our model that relies on parameters relating to the retention decision, the effort decision, and the relationship between ability and compensation. In this chapter, we discuss how we developed the empirical model and, specifically, how we calibrated these parameters.

RETENTION AND FORCE STRUCTURE

Rather than attempt to fit the theoretical model with data from all four services, we calibrated the model using data from the Army enlisted force and the Army Unrestricted Line Officer (URL) force. Because retention patterns in the other services are similar, the broad policy inferences obtained from an analysis of these groups should transfer to other groups.

The steady-state grade-by-YOS distribution of a given force will depend on many factors. The three crucial factors are the lengths of the initial enlistment and reenlistment contracts, promotion rates and timing, and retention rates. To implement the model empirically, we had to make some simplifying assumptions about enlistment contracts. In reality, there is an almost infinite variety of enlistment and reenlistment contract lengths that would be extremely difficult to

model without individual-level data. Enlistees in the Army join for periods of 2 to 4 years while Navy enlistees join for periods of 3 to 6 years. Once initial enlistments are completed, enlisted personnel can either extend their current enlistment contract for up to 2 years or reenlist for periods of 3 to 6 years. Without individual-level data, keeping track of the possibilities would be impossible. We therefore simplify the model considerably by assuming that enlisted personnel initially enter for 4 years and then reenlist thereafter for 4-year periods. However, we assume that once personnel reach YOS 20 and are eligible to retire, they make annual retention decisions thereafter. This assumption seems to be supported by the data—the continuation rates of those not at their estimated time of separation (ETS) are much lower after YOS 20 than before, indicating less-rigid enforcement of enlistment contracts and more-frequent retention decisionmaking beyond YOS 20.

Officers are treated slightly differently. Depending upon commissioning source, most officers enter for 4 or 5 years (although some, like pilots, incur longer obligations). For simplicity, we assume that all officers make their initial retention decision in YOS 4. Unlike enlisted personnel, after fulfilling their initial obligations officers do not sign fixed-length reenlistment contracts. Rather, they agree to stay for variable lengths of time in return for such things as accepting a promotion, a new assignment, or extra training. We are told that the typical commitment brought about by promotion and reassignment is 3 years. Therefore, we assume that after the initial retention decision, officers make their retention decisions every third year.

We chose FYs 1987–1989 as a representative period for data on promotion rates and force structure. Promotion rates began to decline after 1989 as a result of the drawdown and therefore may not be representative of steady-state promotion opportunities. The services do not publish grade-by-YOS data on enlisted promotion probabilities. We had to use data supplied by Defense Manpower Data Center (DMDC) to compute them for Army enlisted personnel. DMDC makes available data by FY on end strengths, promotions, and losses by grade and YOS. The promotion rate from a given grade-YOS cell was calculated as proportion of personnel in the given grade-YOS cell at the end of each FY that both stayed and was promoted during the next FY. We then calculated the three-year (FYs 1987–1989) average of these rates.

Promotion data for officers were provided by the Officer and Enlisted Personnel Management (OEPM) branch of the Office of the Undersecretary of Defense for Personnel and Readiness. OEPM reports the promotion rate of unrestricted line officers and their average YOS at promotion by FY. We used an average of FYs 1987–1989 rates in our model and massed the promotion probability at the average YOS at which officers are promoted. This procedure is reasonable since officers are promoted in tight intervals around the average YOS at promotion.

Finally, to calibrate the model, we built steady-state forces that mimic as closely as possible the force structure and retention patterns that prevailed in FYs 1987–1989. The calibration takes place as follows. Consider personnel entering service during a given FY. Between the time of entry and the end of the FY some promotions occur but some attrition also occurs. We used actual FYs 1987–1989 data on Army enlisted personnel to distribute new entrants by paygrade and YOS at the end of YOS 1 and to specify the YOS 1 loss rate. In the enlisted model, we then compute flows into the different grades in YOS 2 based on FYs 1987–1989 promotion rates and the FYs 1987–1989 average of Army enlisted *non-ETS* continuation rates for YOS 2. These flows are then adjusted to account for prior-service gains based on an average of FYs 1987–1989 prior-service gain rates into YOS 2. We repeat the process for YOS 3.

Behavior or choice begins to occur in YOS 4. Choice is based on the expected gain to staying. Conceptually, each member of the cohort that survives to YOS 4 has a gain to staying (or cost of leaving) that is based on (1) the military pay table, the retirement system, and the civilian pay stream that he or she faces; (2) future promotion probabilities and service high-year-of-tenure (HYT) policies; (3) the member's taste-for-service factor (τ); (4) the service member's ability (α); and (5) the distribution of the random factor in retention decisions (ε). As described in Chapter Two, the gain to staying is a probabilistic weighting of the payoffs to staying to the various future YOS points and then separating, where the probability weights depend on the strength of tastes for service and therefore vary according to the taste factor τ and the ability factor α. The cohort retention rate is derived as a weighted average of the probabilities of staying for different values of τ and α. An efficient method for per-

forming these calculations is described in Black, Moffitt, and Warner (1990).

The proportion of the YOS 4 cohort that stays (in a probabilistic sense) is then "aged" by YOS and grade over the next 4 years based on FYs 1987–1989 promotion rates by grade and YOS and FYs 1987–1989 non-ETS continuation rates. The fraction that survives to (each grade in) YOS 8 is then allowed to make another retention decision, which is again based on the factors identified above. The process then repeats itself over the next 4-year interval, and so forth.

The officer model differs in three ways. First, as mentioned above, officers are permitted to make retention decisions every 3 years after the initial decision rather than every 4. Second, we did not have the continuation rates of officers who are not at the end of an obligation (as we did for enlisted personnel). But we inferred from examining the data that officer loss rates due to non-ETS attrition (death, disability, etc.) are low, much lower than is the case for enlisted personnel. We therefore arbitrarily set the annual officer loss rate at the nondecision points to be .02. Third, since we did not have gain rate data for officers, the officer model does not permit the limited lateral entry that occurs among the enlisted force.

Finally, in both the officer and enlisted models, the continuation rate in a given grade-YOS cell is set to zero if the YOS is equal to or greater than the grade's HYT. To make the model fit the observed FYs 1987–1989 force better, in some cases the HYT is relaxed a year or two because significant numbers of personnel are observed who have YOS above the nominal HYT. For example, although the Army's nominal HYT for E-8s is 24, in the FYs 1987–1989 era there were significant numbers of E-8s in YOS 25 and YOS 26. Therefore, we set the E-8 HYT to be 26.

The retention pattern and the resulting force structure predicted by the model are controlled by varying the three model parameters—the mean of the initial taste distribution (μ or MUT hereafter), the standard deviation of this distribution (σ_τ or SDT hereafter), and the standard deviation of the random disturbance distribution (σ_ε or SDE hereafter). For example, increasing MUT raises retention at all YOS points (although early retention is most affected). Raising the variation in tastes, SDT, may increase or decrease retention, depend-

ing upon the levels of military and civilian pay. The YOS pattern of retention depends on the importance of random factors in the retention process relative to tastes. Random factors are less important the smaller the SDE. The smaller the SDE, the more retention tends to rise with YOS beyond the initial retention decision. In fact, if SDE were zero, then retention rates would jump to unity after the initial retention decision (as long as the gain to staying rises with YOS). That voluntary retention rates do not increase so sharply indicates that random factors are important.[1]

Table 3 shows the actual grade-by-YOS of Army enlisted personnel for the FYs 1987–1989 period. The distribution is virtually the same as the FY 1990 distribution. Based on an average of FYs 1987–1989 continuation rates, the table shows what fraction of an entry cohort would survive to various YOS. About 34 percent would survive to YOS 5; 12 percent would survive to YOS 20 and become retirement eligible. If the continuation rates were steady state, the Army would get 5.31 manyears per accession on average. The average enlisted strength during this period was 647,187, and the Army would require 121,785 accessions per year to sustain this size force based on the FYs 1987–1989 continuation rates.

An unsettled question is the rate at which personnel discount future dollars. Some previous research [Gilman (1976), Black (1983), Lawrence (1991)] suggests that personnel discount future dollars at fairly high rates. In their recent estimation of the dynamic retention model, Daula and Moffitt (1992) claim, in fact, to estimate it econometrically and obtain an estimate of 9.9 percent. The drawdown is providing more evidence on discount rates. The high percentage choosing the lump-sum separation payment over an annuity also may be indicative of high personal discount rates.[2] We therefore calibrated the model at a rate of 10 percent for all personnel.

[1]The Army's FYs 1987–1989 average ETS retention rate at YOS 4 was 35 percent. At YOS 8, it was 64 percent and, at YOS 12, it was 80 percent.

[2]Almost 90 percent of the enlisted personnel and 60 percent of the officers are choosing the lump-sum payment rather than the annuity. We have calculated that the break-even real discount rate on this choice is about 12 percent. This is not a clean test of discount rates, however, since other aspects of the choice are not the same. For instance, those who take the lump sum get medical care and commissary privileges not available to those who choose the annuity. The biggest difference is that annuity takers who subsequently join the reserves would lose some of their annuity while

Table 3

Actual FYs 1987–1989 Army Enlisted Personnel Data

	Grade-by-YOS Distribution					
YOS	E-1–E-3	E-4–E-6	E-7–E-9	Total	Survival to Start of YOS:	
1–4	28.0	21.7	0.0	49.7	5	.338
5–10	0.7	25.7	0.1	26.4	10	.189
11–20	0.0	13.0	8.5	21.5	20	.120
21–30	0.0	0.1	2.2	2.3	30	.005
Total	28.7	60.5	10.8			

Manyears per accession = 5.31

Accessions based on force of 647,187 = 121,785

Table 4

Model Fits for Enlisted Personnel[a]

	Grade-by-YOS Distribution					
YOS	E-1–E-3	E-4–E-6	E-7–E-9	Total	Survival to Start of YOS:	
1–4	31.3	20.7	0.0	52.0	5	.307
5–10	0.0	24.8	0.3	25.1	10	.164
11–20	0.0	14.0	7.1	21.1	20	.107
21–30	0.0	0.0	1.8	1.8	30	.001
Total	31.3	59.4	9.2			

Manyears per accession = 5.35

Accessions based on force of 647,187 = 120,925

[a]Based on the following assumptions: Personal discount rate = 10 percent; MUT = 0; SDT = 3,000; SDE = 40,000.

Table 4 shows the model parameters that yield simulated retention patterns and a force structure that was as close to the observed FYs 1987–1989 force as we could get. While the model fit is not exact, it is close: The force has virtually the same experience mix, the same survival to YOS 20, and a roughly similar grade distribution.

lump-sum takers would not have any future offset. The role of discount rates in the observed choices is therefore still in doubt.

Manyears per accession are slightly higher in our simulated force, and required accessions are slightly lower than in the actual force. This result is caused by our assumption that all entrants enlist for 4 years. A significant proportion of Army entrants enlist for 2 or 3 years, which lowers the Army's actual manyears per accession. Nevertheless, the point is not to perfectly predict the actual force, but to build a hypothetical force with characteristics as close as possible to the observed one with our simplifying assumptions and then study how that force would react to changes in compensation and personnel policy.

A key test of the model's plausibility is whether its predictions of the response to changes in compensation are consistent with available empirical evidence. To find out, we simulated the effects of the following: (1) offering a Selective Reenlistment Bonus (SRB) (with multiple = 1) available at YOS 4, (2) offering an SRB at YOS 8 (with multiple = 1), and (3) a 10 percent across-the-board increase in basic pay. The results of these experiments are shown in Tables 5 and 6. Consider the effect of a one-level increase in the first-term bonus

Table 5

Model Tests for Enlisted Personnel

Retention Rate Before Bonus	Retention Rate After Bonus
Level-1 Selective Reenlistment Bonus Paid at YOS 4	
.400	.427
Level-1 Selective Reenlistment Bonus Paid at YOS 8	
.642	.676

Table 6

Effect of 10 Percent Across-the-Board Real Pay Increase

YOS	Retention Rate Before	Retention Rate After	Implied Elasticity
4	.400	.478	1.95
8	.642	.743	1.57
12	.852	.900	.40
16	.926	.948	.24

multiplier. The retention rate is predicted to rise by .027. The bonus at YOS 8 is predicted to raise the YOS 8 retention rate by .034. These predictions are within the range of estimates provided by econometric studies of military bonus programs [see, e.g., Smith, Sylwester, and Villa (1991)].

The elasticity of retention with respect to pay is defined as (percentage change in retention)/(percentage change in pay). The first-term pay elasticities implied by the model's predicted response to a 10 percent increase in basic pay is 1.95. These pay elasticities, as well as the lower values found at later terms (Table 4), are again well within the range of econometric evidence. Evaluated on grounds of plausibility of the responsiveness of retention to changes in pay, the model seems well calibrated.

Table 7 and 8 show the model fit for officers. The model predicts survival to various YOS points reasonably well. It underpredicts somewhat survival to YOS 6 and YOS 10 but the predicted survival rates to YOS 20 and YOS 30 are close to rates based on FYs 1987–1989 data. Because it underpredicts slightly the survival to YOS 10, the steady-state force predicted by the model has about 3 percent more personnel in the YOS 1–4 than did the actual FYs 1987–1989 force and about 3 percent less in the YOS 5–10 range. The percentages in the simulated forces in YOS 11–20 and YOS 21–30 are closer to the observed percentages. The model grossly underpredicts the percentage of the force in grades O–1 through O–3 and overpredicts the number in O–4 and O–5. The reason is apparent from a comparison of the actual and simulated force distributions in Tables 7 and 8. In the actual force, 6.6 percent of the officers were O–1 through O–3 in the YOS 11–20 range. But in our model, personnel who fail to reach grade O–4 by YOS 11 are forced to separate. O–1 through O–3 personnel beyond YOS 11 appear in the actual force for several reasons: (1) the YOS in the reported data are based on total active federal service, which may include service in enlisted status; (2) some may be reservists who have come on active duty; and (3) personnel may have been selected for promotion but have not yet been promoted. The distinction between selection and actual promotion is particularly important in the field grades, where personnel selected for promotion often have to wait a year or more between selection and actual promotion. In the model, there is no lag between selection and ac-

Table 7

Actual FYs 1987–1989 Army URL Officer Data

	Grade-by-YOS Distribution					
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	29.9	0.1	0.0	29.9	6	.588
5–10	31.2	0.2	0.0	31.4	10	.459
11–20	6.6	22.2	0.0	28.8	20	.285
21–30	0.0	5.9	4.0	9.9	30	.022
Total	67.7	28.3	4.0			

Manyears per accession = 10.38

Accessions based on force of 71,135 = 6,856

Table 8

Model Fits for Officer Personnel[a]

	Grade-by-YOS Distribution					
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	32.8	0.1	0.0	32.9	6	.567
5–10	25.0	0.3	0.0	28.2	10	.456
11–20	0.0	29.7	0.0	29.7	20	.297
21–30	0.0	5.1	4.1	9.2	30	.010
Total	57.7	38.1	4.1			

Manyears per accession = 40.44

Accessions based on force of 71,135 = 6,814

[a]Personal discount rate = 10 percent; MUT = 2,000; SDT = 8,000; SDE = 35,000.

tual promotion, hence the overprediction of O–4 and O–5 personnel. But overall the steady-state grade-by-YOS distribution and survival patterns predicted by the model are close to those actually observed.

Simulated effects of a 10 percent across-the-board increase in officer pay are shown in Table 9. The predicted effect at YOS 4 is substantial, even larger on a percentage basis than the enlisted response. Like the enlisted case, the predicted elasticities diminish at later terms. How plausible are these elasticities? The answer is, we do not know. Empirical studies of the effect of compensation on officer re-

Table 9

Model Tests for Officer Personnel: Effect of 10 Percent Across-the-Board Real Pay Increase

YOS	Retention Rate Before	Retention Rate After	Implied Elasticity
4	.642	.748	1.65
7	.844	.886	0.50
10	.948	.960	0.13
14	.984	.984	0.00
20	.825	.849	0.29
24	.825	.839	0.17

tention are scant. A recent econometric analysis of Army Signal Corps and Infantry officer retention by Mackin, Hogan, and Mairs (1993) provides lower estimated pay elasticities than ours.[3] To the extent that the retention decisions of Army officers are less responsive than those implied by the model, the model will overpredict the force structure effects of changes in retired pay and the active duty pay changes required to offset those changes. On the other hand, there are reasons tc believe that econometric estimates of officer pay responsiveness will be downward biased.[4]

[3]The Mackin, Hogan, and Mairs estimates imply that a 10 percent increase in pay will increase the probability that an Army Signal Corps officer will remain in service from YOS 4 to YOS 10 by 15.5 percent. The change for Infantry officers is 9 percent. By contrast, our model predicts that officer retention will increase by 22.4 over the interval YOS 4 to YOS 10 as a result of a 10 percent pay increase.

[4]Studies of officer retention are likely to produce downward biased estimates of pay responsiveness for several reasons. We cite only two that are likely to apply specifically to officers. First, officers do not have explicit observable contract lengths as do enlisted personnel. Therefore, studies of officer retention like the Mackin, Hogan, and Mairs study assume officers are free to make an annual stay-leave decision, even when they may not be because of implicit obligations arising from training, changes of duty station, etc. Pay responsiveness will be understated because such obligations prevent some personnel from leaving even when they would like to because of pay reductions. Second, some officers leave even when they would like to stay either because they have been passed over for promotion and are involuntarily separated or because of the prospect of this happening at some point in the future. Failure to control for the effect of personnel policies like mandatory separation is also likely to dampen the relationship between pay and retention.

COMPUTING ABILITY AND EFFORT SUPPLY

In addition to estimating the force structure implications of alternative compensation structures, the simulation model also estimates the implications for the average ability level and the average amount of effort supplied by the force. To incorporate the role of ability, we first posit a standard normal probability distribution of ability among the entry cohort. We then allow different ability types (captured by deviations from the mean ability level) to affect earnings in alternative employment (i.e., civilian earnings) and to affect the probability of promotion in each grade and YOS. We proxied these effects by using previous estimates of the relationships between AFQT (Armed Forces Qualification Test) scores and civilian earnings and between AFQT scores and promotion probabilities.[5] While AFQT score is not a direct measure of ability, it is thought to be a strong correlate of it.[6]

In calibrating the model, we had to make an assumption about the correlation between individuals' tastes for service and their ability. We calibrate the model assuming no correlation between tastes and ability.

As discussed in Chapter Two, of particular interest from a policy standpoint is how compensation and personnel policy affects the organization's ability to provide an incentive for the most able to stay and seek advancement. To measure the "ability sorting" effects of alternative retirement policies, we therefore computed both the average ability level of the force as well as the average ability of personnel by grade. Since the units in which ability is measured are set arbitrarily, the *changes* in ability and ability sorting as a result of *changes*

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[5]These previous estimates are obtained from Smith, Sylwester, and Villa (1991).

[6]In our model, civilian earnings for an individual who separates in grade i and year of service t and who is in his jth year of civilian employment is given by $c_{i,t,j} = c^*_{i,t,j} \cdot \exp(\beta_\alpha \alpha)$ where $c^*_{i,t,j}$ is expected earnings based on his observable characteristics (education, race, sex, etc.), α is ability, and $\exp(\beta_\alpha \alpha)$ is the contribution of ability to civilian earnings. The parameter β_α shows the proportionate effect of a unit change in ability on alternative earnings possibilities. In our simulations, we assume that β_α (also denoted Beta_A in what follows) equals .1 so that persons whose ability is one standard deviation above average have a 10 percent higher earnings capacity. The effect of ability on the promotion probability distribution function is assumed to be .15 in the enlisted model and .30 in the officer model.

in policy will be of primary interest rather than the absolute levels of ability under each policy, per se.

Incorporating effort supply into the model is more complicated because, like the retention decision, the optimal effort supply decision for each individual is made in each grade and YOS and is both a forward-looking and backward-looking decision process. Furthermore, the decision will differ for individuals of different taste and ability types. To incorporate these factors, we first defined "individuals" in terms of standard deviations from the mean of the taste distribution and standard deviations from the mean of the ability distribution. We then solved for each "individual's" optimal effort level in each grade and YOS interatively using Newton's Method.[7]

As discussed in Chapter Two, the optimal effort is given at the point where the marginal benefit of effort equals the marginal cost of supplying it. Two factors importantly affect the marginal benefit: (1) the effect of effort on the probability of promotion and (2) the return to being promoted (including the increment in basic pay, in status and rank in the current period, and in future periods as a result of the promotion). The second factor is given by policy in our model. Thus, calibrating the model's effort parameters required making assumptions about the effect of effort on the probability of promotion and about the marginal cost of effort.

Given our general lack of knowledge about what values these parameters should take, these assumptions will necessarily be arbitrary. Indeed one of the reasons for using a simulation rather than an estimation approach is the lack of data on effort. Although the setting of the effort-related parameters is somewhat arbitrary, recall that our focus is on how optimal effort changes when policy changes and not on the absolute level of effort supplied. Thus, we want to set the parameters so that the results are not strongly affected by changes in their assumed values.

Consider our specification of the marginal cost of effort. Marginal cost is assumed to be linear in effort (i.e., marginal cost equals $10e_{it}$,

[7]For a generic description of how to use this method to numerically solve derivatives, see Press, Teukolsky, Vettering, and Flannery (1992), p. 355.

where e_{it} is effort in grade i in period t).[8] Raising and lowering the linear term by a factor of 10 (from 10 to 100 and from 10 to 1, respectively) had no effect on the force structure and cost results. However, as expected, average effort under the current pre-1980 retirement plan falls dramatically when the marginal cost is higher (equal to $100e_{it}$) and rises when it is lower (equal to e_{it}).[9,10]

We also had to make some assumptions about the effect of effort on promotion probabilities. In our theoretical model, the military evaluates the individuals seeking advancement and then selects some fraction for promotion. Individuals increase their evaluations in these contests and thus their probability of promotion by either being more able or by supplying more effort. The individual's probability of promotion also depends on the ability and effort supply of all the other individuals vying for promotion.

Incorporating such contests into our empirical model at each grade and YOS for each ability and taste type of individual would add many layers of complexity into our model and would involve making specific assumptions about the military's evaluation process, and how effort and ability interact to affect an individual's evaluation and thus one's promotion chances. To minimize the number of assumptions we had to make, we first assumed that individual effort decisions have no effect on the Army's aggregate promotion rate into each grade at each YOS. Given the large numbers of individuals who are competing for promotion at any given point, this assumption seems reasonable. However, we also assume that individuals view their own effort as having a positive effect on their individual chances of promotion and thus their marginal benefit of effort. After some experimentation, we set the effect of effort on the probability of pro-

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[8]More specifically, in the enlisted model we assume that the disutility (or cost) of effort is given $5(e_{it})^2$ so that the marginal cost of effort equals $10e_{it}$. In the officer model, we let the disutility of effort be $10(e_{it})^2$ so that marginal cost is $20e_{it}$.

[9]When the enlisted marginal cost equals $100e_{it}$ rather than $10e_{it}$, manyears per accession remain the same but average effort falls from 3.53 to 1.12. When the marginal cost equals e_{it}, manyears per accession are again virtually the same but average effort rises from 3.53 to 13.6. Average ability also remains unchanged. The asymmetry in the average effort results is due to the quadratic functional form of the cost-of-effort function.

[10]Because all practical results were unaffected, we made the intercept of the effort disutility function larger for officers primarily to spare computer time.

motion (denoted Beta_E) equal to .01. Increasing Beta_E to .1 increases the average optimal effort in the force but has little effect on retention patterns. Similarly, reducing this parameter by a factor of 10 (to .001) reduces average optimal effort but has little force structure or cost effect. The average ability level of the force changes very little as well.

COST ANALYSIS

Once the model builds a steady-state force, it costs that force. The two costs we focus on in the analyses below are the annual basic payroll cost and annual accrual cost of the retirement system. The accrual charge is calculated using the method described in the appendix.[11] The model also calculates several other interesting costs. One is the expected present value of the stream of basic pay to be paid to a new entrant and the expected retirement liability incurred by the new entrant. The expected present value of basic pay is calculated based on the model's predictions of the probabilities that an entrant will survive to occupy future grade-YOS combinations. The present value of the retirement liability is calculated based on the model's prediction of the probability that an entrant will separate from each future grade-YOS cell. Since the DoD actuary uses a 2 percent real interest rate in its calculations, so do we.

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[11]See Grissmer, Hosek, and Eisenman (unpublished) for an alternative accrual calculation method appropriate for a nonsteady-state environment.

Chapter Five

ANALYSIS OF ALTERNATIVE RETIREMENT SYSTEMS

This chapter uses our calibrated model to analyze a number of modifications to the military compensation system. We begin by predicting the steady-state force structure and productivity consequences of the FY 1981 and FY 1986 modifications to the retirement system. We then analyze a recent proposal by the Senate Armed Services Committee (SASC) to provide YOS 11–19 separatees with an old-age annuity but maintain other features of the retirement system. We call this "Band-Aid" vesting. Following our analysis of Band-Aid vesting is an analysis of another method of providing earlier retirement benefits, dropping from 20 to 15 years the length of service required for an immediate annuity. Neither Band-Aid vesting nor a 15-year retirement system appears to be very attractive on grounds of force structure, productivity, or cost. We therefore develop several alternatives of our own that appear to have desirable features.

THE THREE CURRENT MILITARY RETIREMENT SYSTEMS

There are three military retirement systems now in effect. In brief, pre-1980 entrants who complete YOS 20+ receive a lifetime, inflation-protected annuity according to the formula .025*YOS*final basic pay. FYs 1981–1986 entrants who complete YOS 20+ sometime after the year 2000 will receive a lifetime, inflation-protected annuity according to the formula .025*YOS*high-3 years' average basic pay. Post-1986 entrants who serve less than 30 YOS will receive a reduced annuity until age 62 but the same annuity as FYs 1981–1986 entrants beginning at age 62. These annuities, however, will not be fully in-

flation protected; rather they will be allowed to erode in real value at the rate of 1 percent per year. Finally, personnel who reach a HYT point in the YOS 11–19 range (e.g., O-3s at YOS 11) receive involuntary separation pay according to the formula .1*YOS*final basic pay.

For purposes of comparison with what follows, Table 10 shows the annuities that separatees from various ranks and YOS would receive under these three systems. The amounts are based on the January 1992 basic pay table. We assumed a 4 percent annual rate of nominal pay growth to calculate the effect of basing annuities on high-3 averaging. High-3 averaging is calculated to reduce the real value of the annuities by about 6 to 7 percent.

The model was calibrated using the pre-1980 military retirement system. We began by asking what would be the effect on force structure, effort supply, and ability sorting and the costs of the move from the pre-1980 system to the FYs 1981–1986 system. According to our simulations, high-3 averaging has a small effect on the force structure. High-3 averaging changes the percentage distributions of the officer and enlisted forces in Tables 1 and 3 toward slightly less experienced forces, raising accessions and lowering manyears per accession. Officer manyears per accession drop from 10.44 to 10.22, while enlisted manyears per accession drop from 5.35 to 5.26. These changes are minor and imply required accession increases of less

Table 10

Annual Retired Pay Under the Three Current Military Retirement Systems

Grade/YOS	Pre–FY 1980	FYs 1981–1986	Post–FY 1986 (First tier)
O-4/20	$22,435	$20,852	$16,681
O-5/22	$28,518	$26,965	$23,043
O-6/26	$39,417	$37,542	$35,232
O-7/30	$56,144	$53,536	$53,536
E-7/20	$12,029	$11,320	$9,056
E-8/25	$18,227	$17,105	$15,737
E-9/30	$27,294	$26,110	$26,110

than 2 percent. Given these small retention effects, it is not surprising that the changes in average effort and ability are small as well.[1]

The model predicts that the REDUX (post-1986) system will have a more noticeable impact. Tables 11 and 12 show the predicted force structure under REDUX when promotion opportunities are held constant. REDUX is predicted to reduce the probability that an officer entrant will stay for a 20-year career from .297 to .270 and the

Table 11

Predicted Effects of Post-1986 Retirement System on Officers (REDUX or Retirement System 3)

	Grade-by-YOS Distribution				Survival to Start	
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	of YOS:	
1–4	33.9	0.1	0.0	33.9	6	.544
5–10	24.0	3.1	0.0	27.1	10	.420
11–20	0.0	28.2	0.0	28.2	20	.270
21–30	0.0	6.1	4.6	10.7	30	.020
Total	57.9	37.5	4.6			

Manyears per accession = 10.03
Accessions based on force of 71,135 = 7,091

Table 12

Predicted Effects of Post-1986 Retirement System on Enlisted Personnel (REDUX or Retirement System 3)

	Grade-by-YOS Distribution				Survival to Start	
YOS	E-1–E-3	E-4–E-5	E-6–E-7	Total	of YOS:	
1–4	33.1	21.6	0.0	54.8	5	.294
5–10	0.0	24.4	0.3	24.7	10	.145
11–20	0.0	12.2	6.4	18.5	20	.086
21–30	0.0	0.0	2.0	2.0	30	.002
Total	33.1	58.2	8.7			

Manyears per accession = 5.06
Accessions based on force of 647,187 = 127,883

[1]Tables for retirement system 2 are not shown because the effects are minor.

probability that an enlisted entrant will stay from .107 to .086, declines of about 10 percent and 20 percent, respectively. Accessions required to maintain a constant force level rise by about 5 percent. We estimate that the deleterious retention effect of REDUX could be offset by an active duty pay raise of 3 percent.[2] Notice the other effect of REDUX—it significantly increases post–YOS 20 retention. These effects were to be expected given the increase in the retirement multiplier and less than full inflation indexing. In fact, when promotion opportunities are held constant, the fraction of both the enlisted and officer forces in the senior paygrades is predicted to increase, causing the Army to potentially violate its grade table constraints. We therefore reran the model, reducing promotion opportunities to the senior grades enough to maintain the base case fraction of forces in these grades. The results of this analysis reveal a further drop in manyears per accession and an increase in accession requirements. Under REDUX, officer manyears drop to 9.90, compared with 10.03 when promotion opportunities are held constant. However, the effects are not large, so we do not report results with reduced promotion opportunities to the senior grades here.

The estimated effects of the three retirement systems on the average optimal effort and average ability of the force in the steady state are shown in Table 13. In Figure 1, we compare ability sorting under each retirement system by graphing the average ability of the enlisted force in each grade.[3] The largest effects occur under REDUX (Current 3) relative to the pre-1980 (Current 1) plan. The average effort level for the enlisted force is estimated to fall by over 5 percent under REDUX relative to Current 1 because of the drop in benefit levels, especially for those who retire at 20 years. However, estimated average effort for those who stay beyond 20 years rises almost 15 percent under REDUX because the retired pay multiplier is steeply ramped for retirements beyond 20 years. REDUX also affects how well the services are able to attract higher-ability personnel into the upper grades. We estimate smaller intergrade ability differences un-

[2]The amount of the pay raise will depend on the personal discount rate.

[3]Because the ability-sorting effects of the various compensation systems that we examine in this section are similar for officers and enlisted personnel, we show only the effects for enlisted personnel.

Table 13

Steady-State Average Optimal Effort and Average Ability Under Current Compensation Systems

	Current 1	Current 2	Current 3
Officer Force of 71,135			
Ability	–.14	–.15	–.16
Optimal effort	8.58	7.99	8.43
Enlisted Force of 647,187			
Ability	–.19	–.19	–.19
Optimal effort	3.53	3.45	3.32

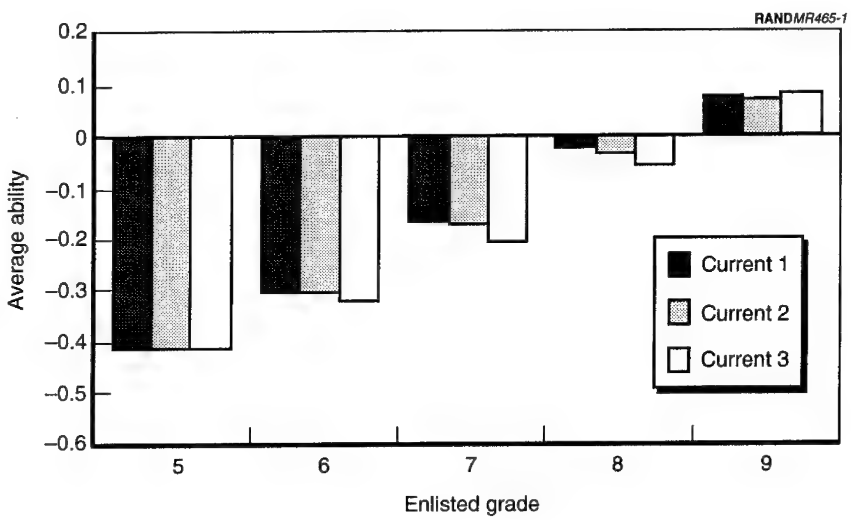

Figure 1—Ability Sorting Under Current Retirement Systems

der REDUX in the more junior grades (E-5 through E-7) because of the drop in benefit levels but larger ability differentials in the more senior grades (E-8 and E-9) because of the steep ramping of the multiplier for those retiring after YOS 20. In fact, REDUX appears to induce greater average effort in the officer force than Current 2 precisely because of its big positive effect on the effort of senior officers.

Costs of the three systems are displayed in Table 14. Under the pre-1980 retirement system (Current 1), for example, the officer force has annual basic pay costs of $2.43 billion, and the enlisted force has a basic pay cost of $9.48 billion. The retirement accrual charge for the officer force under Current 1 is $1.1 billion, or 45.3 percent of basic pay costs. The corresponding charge for the enlisted force is $2.95 billion, or 31.1 percent of their basic pay costs. The accrual charge for our total force is 34 percent of basic pay costs. Basic pay costs drop slightly under the FYs 1981–1986 (Current 2) and post–FY 1986 (Current 3 or REDUX) systems because of their effects on retention. The retirement accrual charge drops also. The accrual charge for the total force drops from 34 percent of basic pay costs under the pre-1980 system to 30.6 percent under high-3 averaging and 23.9 percent under REDUX.

By comparison, the DoD actuary calculates an accrual charge for the whole DoD force (and not just the Army) under the pre-1980 retirement system of 49.6 percent of annual basic pay costs. Similar calculations yield an accrual cost percentage of 43.6 percent under high-3 averaging and 36.8 percent under REDUX. While a number of factors might explain the cost differences, they appear to be the result pri-

Table 14

Steady-State Costs of Current Compensation Systems

	Current 1	Current 2	Current 3
Officer Force of 71,135			
Annual payroll costs (billions)			
Basic pay	2.43	2.43	2.43
Retirement accrual	1.10	0.99	0.85
Total	3.53	3.42	3.28
Per capita accession costs (thousands)			
Basic pay	290.0	283.6	278.2
Retirement accrual	134.9	119.4	100.3
Enlisted Force of 647,187			
Annual payroll costs (billions)			
Basic pay	9.48	9.43	9.31
Retirement accrual	2.95	2.64	1.95
Total	12.43	12.07	11.29
Per capita accession costs (thousands)			
Basic pay	68.6	67.3	64.3
Retirement accrual	21.6	19.0	13.6

marily of survival rates upon which the actuary's calculations are based being higher than the Army's, upon which our model is calibrated. In the DoD actuary's model, 65 percent of officer entrants survive to YOS 20, as do 14 percent of enlisted entrants. These rates are 2.18 and 1.31 times higher than our respective officer and enlisted rates. If we multiply our officer and enlisted accrual costs by these ratios, total them, and then divide by total basic pay costs, we obtain accrual charges of 53 percent for the pre-1980 system, 47 percent for the FYs 1981–1986 system, and 37 percent for the post–FY 1986 system. These charges are close to the DoD actuary's calculated charges, suggesting that most of the calculated cost difference is due to differences in survival patterns in the respective models.

CURRENT SYSTEM WITH BAND-AID VESTING

A policy change that has been recommended on numerous occasions is to vest members in an old-age annuity earlier. Most recently, in 1990 and 1991 SASC discussed earlier vesting in an old-age annuity as part of a package of benefits to service personnel with less than 20 YOS who were being released as part of the drawdown. While the SASC failed to act on earlier vesting, it requested that DoD study it. Indeed, our analysis is in part an outgrowth of that request.

Why earlier vesting? Numerous arguments have been advanced by various groups and commissions in favor of earlier vesting.[4] They included the following: (1) it is fairer than the current system, (2) earlier vesting would bring DoD into closer compliance with ERISA, and (3) earlier vesting might induce the services to modify personnel policies and the desired grade/experience distributions of their forces in desirable ways.

Since any new annuity system is likely to be based on a high-3 averaging of basic pay, we studied the retention effect of adding an annuity that is vested earlier by comparing the FYs 1981–1986 system (Current 2), where annuities for YOS 20+ separatees are based on high-3 averaging, with the same system coupled with old-age annuities for YOS 11–19 or YOS 6–19 separatees. We assume that the old-

[4]See our larger report (Asch and Warner, 1994, Section 2) for a review of the various proposals that have been made to change the retirement system.

age annuity begins at age 60 and that it is based on high–3 years' basic pay. Typical annuity amounts for pre-YOS separatees are shown below.

O-2/6 YOS	O-3/10 YOS	O-4/15 YOS	E-5/6 YOS	E-6/10 YOS	E-7/15 YOS
$3,846	$8,144	$14,659	$2,064	$4,243	$7,873

Our analysis revealed a trivial retention effect of Band-Aid vesting. We also find that adding an earlier vested old-age annuity has a trivial effect on the effort decisions and the incentive of high-ability personnel to stay and seek advancement. The reason for these results is clear: The value today of a benefit that will not be received for another 20 to 35 years is minimal.

Band-Aid vesting would, however, raise costs, as shown in Table 15. Vesting upon completion of YOS 10 would raise the combined officer and enlisted retirement accrual by 7 percent and total manpower costs by 2 percent. Vesting upon completion of YOS 5 would raise the combined accrual charge by 17 percent and overall manpower costs by 4 percent. But because the forces upon which our model is

Table 15

Steady-State Costs of Adding an Earlier Vested Old-Age Annuity

	Current 2	Current 2 + Early Vesting at YOS 10	Current 2 + Early Vesting at YOS 5
Officer Force of 71,135			
Annual payroll costs (billions)			
Basic pay	2.43	2.43	2.43
Retirement accrual	0.99	1.05	1.10
Total	3.42	3.48	3.53
Per capita accession costs (thousands)			
Basic pay	283.6	284.3	284.2
Retirement accrual	119.4	126.7	133.1
Enlisted Force of 647,187			
Annual payroll costs (billions)			
Basic pay	9.43	9.43	9.42
Retirement accrual	2.64	2.85	3.16
Total	12.07	12.28	12.58
Per capita accession costs (thousands)			
Basic pay	67.3	67.3	67.2
Retirement accrual	19.0	20.6	22.8

based do not replicate the all-DoD force and, in fact, have higher pre–YOS 20 turnover than the all-DoD force, the cost of Band-Aid vesting for our hypothetical forces would exceed the cost of all-DoD vesting. The DoD actuary, therefore, calculated the cost of adding an earlier vested old-age annuity for us using his model. According to his estimates, adding an annuity that vests upon completion of YOS 10 would raise the total DoD retirement accrual charge by 3.1 percent ($582 million) while adding one that vests after YOS 5 would raise it by 7.5 percent ($1.4 billion). Our cost estimates are higher (on a percentage basis) because the Army forces upon which our model is calibrated have much higher pre–YOS 20 turnover than the aggregate DoD force upon which the DoD actuary bases his calculations.

Is Band-Aid vesting good policy? Past studies have recommended it because it is "fairer" than the current system to those who separate prior to YOS 20. But the fairness does not come cheaply, and it has no apparent effect on the behavior of personnel, either their retention or work effort. If Band-Aid vesting is good policy, it must be because it would induce the services to modify personnel and manpower policies in ways that ultimately lead to reduced costs, improved force structure, or better individual performance incentives. For instance, with the availability of some retirement benefits for pre–YOS 20 separatees, the services might pursue more aggressive separation policies for underperforming or nonpromotable personnel. In turn, more aggressive separation policies might spur performance as personnel work harder to meet the more stringent standards. Furthermore, if requirements for mid-career personnel are really overstated because of the implicit contracting problem mentioned earlier, then adding an earlier vested annuity might eliminate the incentive for such overstatement and induce the services to revise their objective force profiles to a less rich structure.

The problem with this line of reasoning is that Band-Aid vesting does not alter the large discontinuity in benefits between those who separate before YOS 20 and those who separate after. Consequently, we are skeptical that the services will use Band-Aid vesting as the basis for significant changes in personnel policies and force structure planning.

FIFTEEN-YEAR RETIREMENT SYSTEM

Rather than adding earlier vested old-age annuity, another way to vest earlier is simply to reduce the YOS required for receipt of an immediate annuity. Such a policy is now being considered as part of the ongoing drawdown. We explored the steady-state consequences of a 15-year retirement system. To do so, we compared (1) the FYs 1981–1986 system with 20-year vesting and with 15-year vesting and (2) the REDUX system with 20-year vesting and with 15-year vesting.[5]

Summary retention and productivity statistics and costs of these systems are shown in Table 16. It is clear from the table that a permanent 15-year retirement system would not be desirable for the officer force. In fact, relative to the current FYs 1981–1986 system with 20-year vesting, a 15-year system would have the perverse effect of raising costs while potentially lowering manyears per accession. Why? The availability of an immediate annuity upon completion of YOS 15 produces higher turnover at that point, turnover that today is postponed until YOS 20. But because officer retention prior to YOS 15 is high to begin with, the availability of an annuity upon completion of only YOS 15 does not produce enough additional pre–YOS 15 retention to offset the higher post–YOS 15 turnover. Clearly, in steady-state the officer force would be adversely affected by a 15-year retirement plan.

The enlisted force is a different matter, because, in this case, the availability of an earlier immediate annuity is estimated to raise manyears per accession. Manyears rise because there is more room for the earlier immediate annuity to raise pre–YOS 15 retention. Average effort is estimated to fall slightly, and, as Figure 2 illustrates, intergrade ability differences (i.e., ability sorting) for all ranks are estimated to fall when 15-year vesting is introduced under the FYs 1981–1986 system (Current 2). Although retirement benefits can be obtained earlier, the benefit is calculated using a high–3 year basic pay average that is smaller since basic pay is lower for personnel in

[5]We assume under the REDUX system with 15-year vesting that 15-year separatees will receive an annuity of 22.5 percent of high-3 average basic pay and that each additional YOS thereafter increases the tier 1 annuity by 3.5 percent.

Table 16

Steady-State Costs and Force Structure Effects of Two 15-Year Retirement Systems

	Current 2 with 20-Year Retirement	Current 2 with 15-Year Retirement	Current 3 with 20-Year Retirement	Current 3 with 15-Year Retirement
Officer Force of 71,135				
Annual payroll costs (billions)				
Basic pay	2.43	2.40	2.43	2.43
Retirement accrual	0.99	1.07	0.85	0.91
Total	3.42	3.47	3.28	3.34
Force profile summary % in YOS:				
1–4	33.40	33.8	33.9	33.60
5–10	27.70	28.8	27.1	27.40
11–20	29.20	28.5	28.2	28.30
21–30	9.70	8.9	10.7	10.70
Accessions	6,959	7,001	7,091	7,014
Manyears/accession	10.22	10.16	10.03	10.14
Average effort	7.99	7.44	8.43	8.11
Average ability	–0.15	–0.14	–0.16	–0.15
Enlisted Force of 647,187				
Annual payroll costs (billions)				
Basic pay	9.43	9.37	9.34	9.44
Retirement accrual	2.64	3.12	1.95	3.18
Total	12.07	12.49	11.29	12.62
Force profile summary % in YOS:				
1–4	52.80	52.50	54.8	51.70
5–10	25.00	26.40	24.7	26.40
11–20	20.40	19.60	18.5	20.20
21–30	1.80	1.50	2.0	1.60
Accessions	122,947	121,629	127,883	119,694
Manyears/accession	5.26	5.32	5.06	5.41
Average effort	3.45	3.39	3.32	3.48
Average ability	–0.19	–0.18	–0.19	–0.18

YOS 15 than for those in YOS 20. Thus, the incentive to work harder and the incentive for high-ability personnel to stay and seek advancement is lower under a Current 2 plan vested at YOS 15.

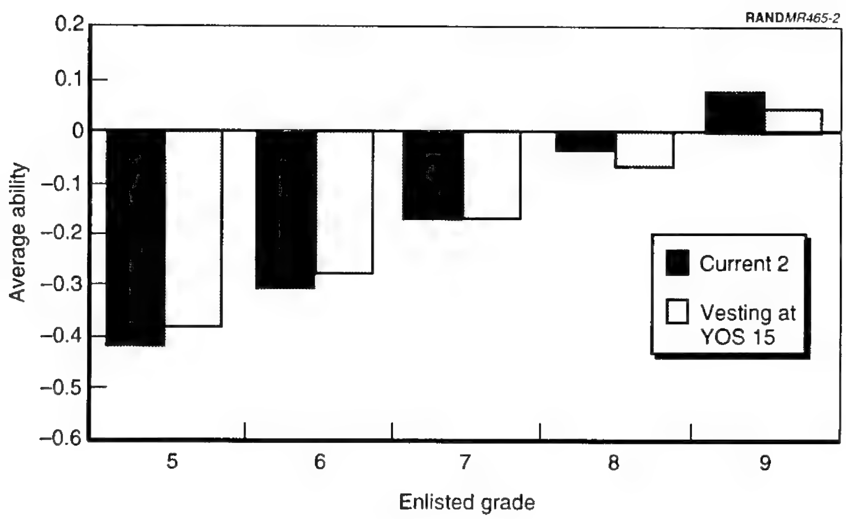

Figure 2—Ability Sorting Under Current 2 System with 20-Year Versus 15-Year Vesting

Manyears per accession also rise under a 15-year REDUX plan (Current 3) for the enlisted force. A 15-year REDUX plan also tends to undo some of the adverse productivity effects of the 20-year REDUX plan relative to Current 1. For example, we estimate that average effort for the enlisted force rises under the 15-year REDUX relative to the 20-year one by nearly 5 percent, thereby offsetting the 5 percent decline that we estimate to occur from the move from Current 1 to Current 3 (the 20-year REDUX plan). Ability sorting improves in the more junior grades under the 15-year REDUX plan as illustrated in Figure 3. Although retirement benefits are smaller under REDUX relative to Current 1 and they are based on high-3 basic pay average (just like Current 2), the steep ramping in the retired pay multiplier occurs earlier under a 15-year vested plan than under a 20-year vested one. High-ability personnel benefit more by this ramping because they are more likely to be promoted to the higher grades. However, ability sorting into the senior grades (E-8 and E-9), which are those that are generally reached beyond YOS 20, is estimated to fall under a 15-year vested REDUX plan.

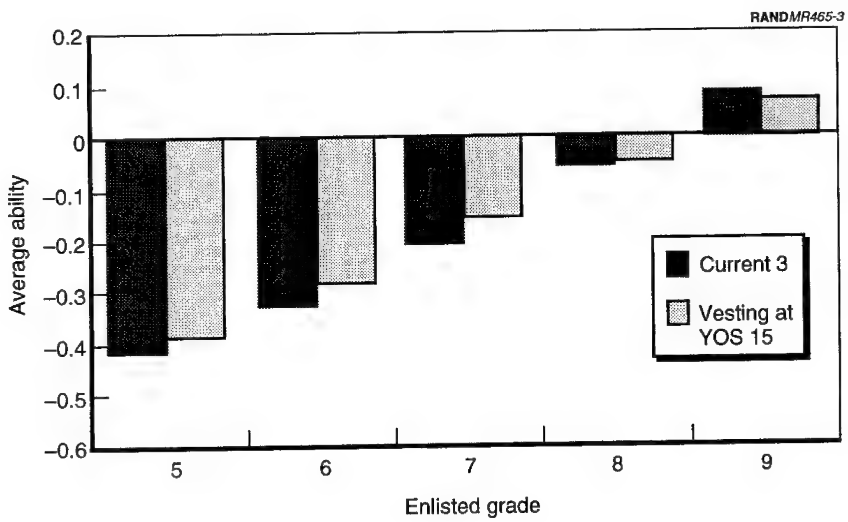

Figure 3—Ability Sorting Under Current 3 System with 20-Year Versus 15-Year Vesting

Neither the extra enlisted effort and ability sorting under Current 3 nor the extra manyears under both Current 2 or 3 come cheaply, however. In the comparison of FYs 1981–1986 (Current 2) systems in Table 16, the 15-year system raises overall force costs by $440 million or 3 percent. Under REDUX, 15-year (rather than 20-year) retirement raises overall force costs by $1.29 billion or 10 percent. The same manyear increases could be obtained significantly more cheaply by active duty pay increases. Overall, a 15-year retirement policy may be desirable as part of a temporary reduction in force, but it does not appear to be a very attractive permanent compensation policy.

SYSTEMS WITH SEPARATION PAY AND OLD-AGE RETIREMENT BENEFITS

As the two preceding sections make clear, in the context of an annuity-based retirement system the alternatives for providing earlier vesting of military retirement benefits do not seem attractive. As the 1978 President's Commission on Military Compensation (PCMC)

recognized, earlier vesting (or any other meaningful change to the system) requires moving away from immediate annuities for YOS 20+ separatees. But neither should the system be changed so radically as to provide no preretirement benefits for senior separatees. Evidence shows that personnel who serve for long periods indeed suffer a second-career earnings loss. Without any transition benefits, the services would be as reluctant to separate senior personnel as they are to separate mid-careerists today. As we show below, a system that does not provide any preretirement benefits would require substantial active pay increases to staff an adequate force. A system that adequately balances the interests of older and younger personnel and provides the services with more flexible force management tools may require cash transition benefits for separating personnel.

If not paid in annuity form, how should the transition benefits be provided? The PCMC recommended establishing a transition benefit trust fund system funded by annual DoD contributions. In retrospect, the PCMC's trust fund concept seems unduly complicated. A simpler vehicle already exists through the involuntary separation pay program. Under this program, personnel who are involuntarily separated between YOS 10 and 19 receive a separation payment equal to .1*YOS*final basic pay. Such a system could be generalized such that separation payments are made to all personnel who satisfy certain eligibility criteria. We examine below several retirement systems that provide YOS 10+ separatees with an old-age annuity (OAA) and a separation payment equal to spm*YOS*final basic pay, where spm is a separation payment multiplier. No immediate annuities are provided. Thus, for YOS 20+ separatees, the separation payment serves as a substitute for the pre–old age portion of the current annuity. The old-age annuity is again assumed to begin at age 60 and is based on the .025*YOS*high-3 average basic pay formula.[6]

[6]After conceiving of these schemes and completing the analysis that follows, we learned that the Japanese Defense Force (JDF) has a similar two-part system of old-age annuities and cash separation payments. It differs in two ways from the plans we evaluate here. First, personnel must serve 20 years to receive an old-age annuity. Second, all separatees receive a lump-sum severance payment no matter how many YOS they have. Also of interest is that the old-age annuities received by JDF retirees are much lower than the annuities now received by U.S. military retirees. The cash severance payments that JDF separatees receive lie somewhere between the amounts that would be provided by the two plans we evaluate below.

We explored two separation payment systems. Under the first, personnel receive the separation payment only if they are involuntarily separated, as when they reach a high year of tenure point in their current grade. The advantage of such a system is that the availability of separation payments only upon reaching a HYT point discourages "premature" losses in grade, and it gives the services more control over the flow of personnel, especially into the higher grades. The disadvantage is that it is not as attractive to young personnel as the second system, under which separation payments are made to all personnel who separate after the minimum vesting period (e.g., YOS 10). The PCMC plan took the latter form and would have made cash separation payments to all post–YOS 10 separatees.

Consider first a system patterned after the current involuntary separation pay system, with spm equal to .1 and in which separation payments are made only to involuntary separatees (which would include those who are separated at HYT points as well as those separated for nonperformance). Separation payments, thus, range from 1 year's final basic pay at YOS 10 to 3 years' pay at YOS 30.[7] Examples of the amounts personnel would receive are shown below. Amounts are based on the FY 1992 pay table.

O-3/YOS 11	O-4/YOS 22	O-5/YOS 26	O-6/YOS 30	O-7/YOS 30
$39,699	$98,715	$139,520	$197,305	$224,575

E-5/YOS 13	E-6/YOS 20	E-7/YOS 22	E-8/YOS 26	E-9/YOS 30
$23,129	$42,696	$53,619	$73,102	$109,177

This system is less beneficial than the current systems to personnel who separate with more than 20 YOS. Even at a 10 percent personal discount rate the lump-sum separation payments shown for YOS 20+ separatees are smaller than the present values of the annuities YOS 20+ separatees now receive between separation and age 60.

[7]These separation payments may be compared with those received by members of the JDF. Ten-year separatees from this force receive 10 months' final basic pay upon separation, while 20-year separatees receive 29 months' pay (almost 2.5 years' pay) and 30-year separatees receive 54 months' pay (4.5 years' pay). Notice that in the JDF system the separation payment rises disproportionately with YOS, in contrast to the linear formula upon which our analysis is based.

The lower value of this system to senior separatees is revealed in the retention and effort supply statistics, and in the cost analysis. Tables 17 and 18 show the estimated force structure and the average effort and ability elicited by this system. Without any other compensation changes, retention and expected manyears decline dramatically. Officer manyears per accession are predicted to decline from 10.44 to 9.72 and enlisted manyears decline from 5.35 to 4.57. Required officer accessions increase by 7 percent; enlisted accessions rise 12 percent. The fraction of the force in the first term (YOS 1–4) rises considerably. Officers are more adversely affected by the alternative

Table 17

Predicted Effects on Officers of Separation Pay/OAA System Vested at YOS 10 (spm = .1)

	Grade-by-YOS Distribution					
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	35.2	0.1	0.0	35.3	5	.587
5–10	26.5	3.2	0.0	29.7	10	.456
11–20	0.0	25.3	0.0	25.3	20	.221
21–30	0.0	5.6	4.2	9.7	30	.026
Total	61.7	34.1	4.2			

Manyears per accession = 9.72
Accessions based on force of 71,135 = 7,320
Average effort = 7.54
Average ability = –.17

Table 18

Predicted Effects on Enlisted Personnel of Separation Pay/OAA System Vested at YOS 10 (spm = .1)

	Grade-by-YOS Distribution					
YOS	E-1–E-3	E-4–E-5	E-6–E-7	Total	Survival to Start of YOS:	
1–4	35.3	22.8	0.0	58.1	5	.281
5–10	0.0	24.1	0.3	24.4	10	.127
11–20	0.0	9.9	5.1	15.1	20	.060
21–30	0.0	0.0	2.4	2.4	30	.005
Total	35.3	56.8	7.9			

Manyears per accession = 4.75
Accessions based on force of 647,187 = 136,323
Average effort = 2.99
Average ability = –.19

because officer entrants are almost three times more likely than enlisted entrants to become long-term careerists and hence receive retirement benefits. There is also a negative impact on personnel effort supply and on how well force managers can identify and promote high-ability personnel. We find that average effort among enlisted personnel falls by 15 percent. Officer effort declines by 12 percent. Intergrade ability differentials are smaller, as illustrated in Figure 4, for the enlisted force.

It is apparent that DoD could not sustain an adequate force under this system. Not only would retention suffer, but so would the incentive to supply work effort. Retention and work effort could be restored either by an appropriate increase in active duty pay or by an increase in the cash separation payment. Therefore, for different values of the spm and assumptions about when individuals are eligible for separation payments, the model was exercised to determine the real pay increase that would be required to maintain a constant quality force. A constant quality force was taken to be one that has the same accession level, the same percentage in YOS 1–4, and the

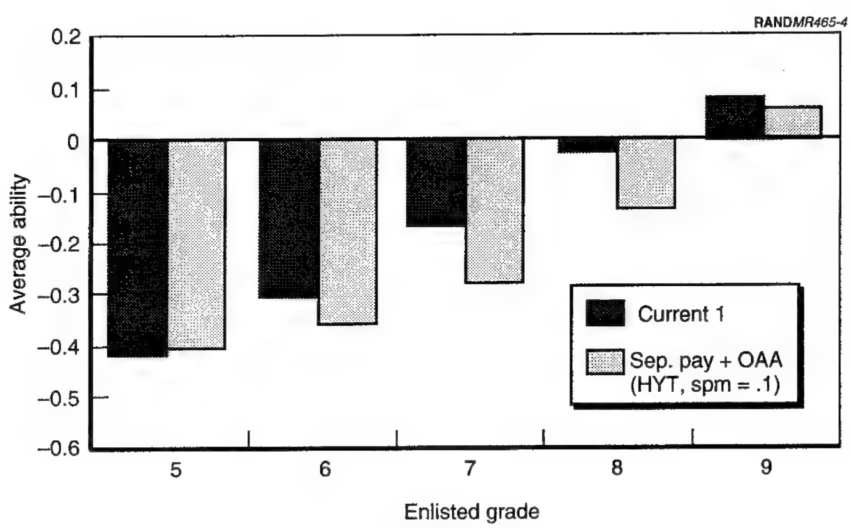

Figure 4—Ability Sorting Under Current 1 System Compared with a Separation Pay/OAA System (spm = .1)

same manyears per accession as the force under Current 1. We experimented with across-the-board increases and with increases that are graduated by rank. Graduated or skewed increases are preferable for the many reasons enumerated in Chapter Two.

Table 19 shows the requisite across-the-board raises for two values of the spm (.1 and .25) and two assumptions about eligibility for separation payments (at HYT only and any YOS beyond 10).[8]

Clearly, the larger the spm, the smaller the pay raise required to maintain a constant quality force. Officers require no pay increase when the spm is set to .25 and no enlisted pay raise is necessary with an spm of .35. Furthermore, the requisite raises are smaller when personnel are eligible for the payment at any YOS beyond YOS 10 than when they may receive it only upon separation at a HYT point. The reason is apparent: Payments at any YOS above 10 have more value to personnel than a system that forces them to stay to a HYT point to collect the separation payment. We show below that the differing eligibility criteria lead to modest differences in the force profile.

Rather than across-the-board raises, raises could be skewed by rank. Based on an spm of .1 and assuming that separation payments are made only to those who separate at a HYT point, Table 20 shows the graduated increases that maintain constant accessions and manyears per accession. Because the increase in senior officer re-

Table 19

Percentage Increase in Basic Pay Required to Maintain a Constant Quality Force Under a Separation Pay/OAA System

	Officers		Enlisted	
spm	HYT Only	All YOS	HYT Only	All YOS
.1	3.5	3.5	7.0	6.0
.25	0.0	0.0	3.0	2.0

[8]The across-the-board raises apply only to the "career" paygrades, O-3 through O-7 and E-4 through E-9.

Table 20

Percentage Basic Pay Raise Required to Maintain Constant Quality Force (spm = .1; separation pay at HYT only)

Officers		Enlisted	
O-3	4	E-5	4
O-4	5	E-6	8
O-5	6	E-7	12
O-6	7	E-8	16
O-7	8	E-9	20

tention was so substantial with fixed promotion probabilities, in the officer analysis that follows, the promotion probabilities of senior officers (O-5 through O-7) are reduced sufficiently to maintain the proportion of the officer force in these grades as in the base case.

Tables 21 and 22 show the force, average effort, and ability that are predicted to evolve with the graduated raises shown above, assuming an spm of .1 and payments at HYT only. A comparison of Tables 3, 4, 5, and 6 with Tables 21 and 22 indicates that although this system provides about the same manyears per accession as the current system, it would yield forces with somewhat different experience mixes. Yet, with the exception of the post–YOS 20 force, the deviations from

Table 21

Predicted Effects on Officers of Separation Pay/OAA System Coupled with Graduated Active Duty Pay Raise (spm = .1; separation payments at HYT only)

	Grade-by-YOS Distribution					
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	32.7	0.1	0.0	32.8	6	.570
5–10	24.6	3.1	0.0	27.8	10	.446
11–20	0.0	28.2	0.0	28.2	20	.279
21–30	0.0	7.2	4.1	11.2	30	.058
Total	57.4	38.6	4.1			

Manyears per accession = 10.47
Accessions based on force of 71,135 = 6,793
Average effort = 9.35
Average ability = –.15

Table 22

Predicted Effects on Enlisted Personnel of Separation Pay/OAA System Coupled with Graduated Active Duty Pay Raise (spm = .1; separation payments at HYT only)

	Grade-by-YOS Distribution				Survival to Start	
YOS	E-1–E-3	E-4–E-6	E-7–E-9	Total	of YOS:	
1–4	31.3	20.8	0.0	52.1	5	.314
5–10	0.0	24.9	0.3	25.3	10	.163
11–20	0.0	12.2	7.0	19.1	20	.089
21–30	0.0	0.0	3.5	3.5	30	.009
Total	31.3	57.9	10.8			

Manyears per accession = 5.36
Accessions based on force of 647,187 = 120,803
Average effort = 4.08
Average ability = –.17

the current system are not large. But the large raises for senior personnel increase the gain to staying in the higher grades and post–YOS 20 retention is, therefore, predicted to increase under the alternative.

The costs of this system are provided in Table 23. The cost of the combined officer and enlisted force falls from the Current 1's $15.96 billion to $15.37 billion, or about $600 million less. The alternative plan reduces the retirement accrual charge by 10 percent and overall system costs by 4 percent without any compromise in the quality of the force.[9]

In addition to this savings, the alternative offers several other advantages that do not appear in costs. First, by skewing the active duty pay profile, it provides a significantly greater reward for promotion as opposed to longevity. As the theoretical model summarized in Chapter Two predicts, greater skewing of the pay table will stimulate work effort and will assist force managers in the identification and advancement of more-able personnel. A comparison of Tables 21 and 22 and Table 13 shows that the average effort supplied by the

[9]Notice, though, that some of the cost of the alternative plan is due to earlier vesting in an OAA. Since vesting in an OAA at YOS 10 adds about $270 million to the retirement accrual, the full cost difference between the alternative plan and Current 1 with a similar early vesting provision is $870 million.

Table 23

Steady-State Costs of Separation Pay/OAA Retirement System (spm = .1; separation payments at HYT only)

	Current 1	With Current Pay Table	With Pay Increase
Officer force of 71,135			
Annual payroll costs (billions)			
Basic pay	2.43	2.42	2.55
Retirement accrual	1.10	0.76	0.81
Total	3.53	3.18	3.36
Per capita accession costs (thousands)			
Basic pay	290.0	269.5	302.6
Retirement accrual	134.9	86.1	100.1
Enlisted force of 647,187			
Annual payroll costs (billions)			
Basic pay	9.48	9.16	10.03
Retirement accrual	2.95	1.47	1.98
Total	12.43	10.54	12.01
Per capita accession costs (thousands)			
Basic pay	68.6	59.7	71.8
Retirement accrual	21.6	9.1	14.4

enlisted force rises over 15 percent relative to Current 1 and over 18 percent relative to Current 2 with Band-Aid vesting. Average officer effort increases similarly. The average ability of the enlisted force rises over 10 percent and intergrade ability spreads increase substantially for the senior grades, as shown in Figure 5.

Second, and perhaps more importantly, the alternative will provide the tools for more flexible force management. One added flexibility is that the services will find it much easier to separate unpromotable or unproductive personnel sooner. For example, they might begin to separate O-4s who are passed over for promotion prior to YOS 20. Another flexibility comes from the enhanced ability to manage the experience profiles in different occupations. For example, HYT points could be set lower for personnel in occupations requiring "youth and vigor" (e.g., combat arms skills), and therefore separation payments could be made available sooner to these personnel. Conversely, HYT points could be delayed for occupations in which longer careers are desirable (e.g., medical personnel).

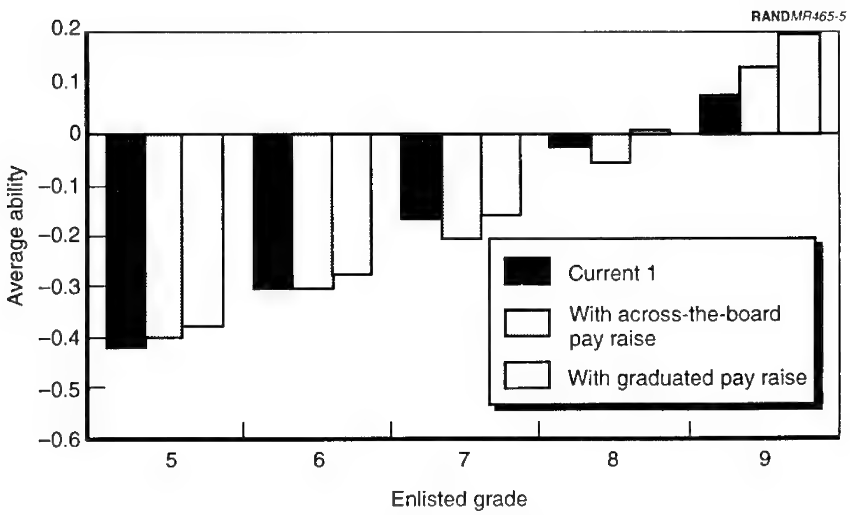

Figure 5—Average Ability Sorting Under Current 1 Compared with Systems with Separation Pay/OAA (spm = .1) Coupled with an Across-the-Board Versus a Graduated Pay Increase

Under the alternative just considered, 20-year separatees would receive 2 years' final basic pay at separation and 30-year separatees would receive 3 years' pay. An objection to this scheme is that the separation payments to these personnel are inadequate. Borjas and Welch (1986), for instance, estimate that the typical enlisted separatee at YOS 20 suffers an earnings loss of about 24 percent in present value over his or her second career. They calculated the dollar loss at about $45,000 in 1976 dollars. The loss scaled to 1992 dollars is roughly $100,000. By contrast, with the pay raises assumed for the analysis in Tables 21 and 22, an E-6 separated at YOS 20 would receive a separation payment of only about $46,000, and an E-7 at YOS 22 would receive only about $60,000. The separation payments might, therefore, be judged to be too small (although under this alternative personnel are compensated for their losses through higher pay). A larger spm would solve the objection that the system is not "fair" to senior separatees. At the same time, a system with larger separation payments would allow the force to be manned with less active duty pay than that shown in Tables 19 and 20.

We, therefore, examined a system that begins the separation payment at 1 year's final basic pay at YOS 10 and then increases it by .25 for each year thereafter (spm = .25), such that under this system, the 20-year separatee would receive 3.5 years' final basic pay at separation and the 30-year separatee would receive 6 years' final basic pay. Put in perspective, compared with the pre-1980 retirement system, this is equivalent to giving the 20-year separatee his first seven years of retired pay in a lump sum. The 30-year separatee would receive his first 8 years' retired pay in a lump sum.[10] Based on the FY 1992 pay table, this scheme would provide the following separation payments.

O-3/YOS 11	O-4/YOS 22	O-5/YOS 26	O-6/YOS 30	O-7/YOS 30
$45,113	$179,482	$241,477	$394,610	$449,150

E-5/YOS 13	E-6/YOS 20	E-7/YOS 22	E-8/YOS 26	E-9/YOS 30
$31,135	$74,718	$97,448	$138,903	$218,354

Our analysis of a system with spm equal to .25 found the following. First, a pay raise would not be required for officers to maintain an adequate officer force. In fact, the officer force profile would be virtually the same as the one in Tables 21 and 22. Pay raises would still be needed to maintain the enlisted force, but the requisite raises would only be less than half of those necessary when spm equals .1. (The enlisted separation payments shown above would, therefore, be slightly larger.) With a graduated pay raise,[11] the steady-state enlisted force is also similar to the one reported in Tables 21 and 22. Average effort and average ability are smaller than those reported in Tables 21 and 22, but they are still substantially higher than the levels elicited by any of the current retirement systems.

Finally, total system cost is virtually the same as the right-hand column in Table 23, indicating that the increase in costs mandated by the larger spm offsets the pay raise required when the spm is smaller.

[10]The retirement system of the JDF was described in earlier footnotes. Notice that the cash separation payments provided by the plan considered here are larger than those paid to separatees from the JDF. The OAAs are also larger.

[11]The graduated pay raises required to maintain a constant quality force when spm = .25 and separation pay is given at HYT only are: E-5 = 1.5; E-6 = 3.0; E-7 = 4.5; E-8 = 6.0; and E-9 = 7.5.

How would a system that makes the payment available to everyone who separates beyond YOS 10 compare with those above, in which the payment is made available only to those who leave at a HYT point (see Tables 21 and 22)? As noted above, when everyone is eligible for a separation payment, the graduated pay increases required to maintain a constant quality force are smaller. This is because eligibility for a separation payment at any YOS beyond YOS 10 increases the value of staying. This system is more attractive than the other system to nonvested personnel. Consequently, it enhances earlier retention and earlier effort and ability levels (although the retention effect is diluted by the smaller pay increase). Beyond YOS 10, however, this system has less "pull" than one that makes separation payments at HYT points only. Consequently, it produces a force profile with somewhat more pre–YOS 10 personnel and somewhat fewer personnel beyond YOS 10. Since the value to staying is less, average effort and ability levels also decline in the later YOS and the more senior grades. This latter effect outweighs the rise in average effort levels among the more-junior personnel so that the average effort level among the force declines relative to the HYT-only case. Average ability levels change little but ability sorting improves in the junior grades and worsens into the senior grades. However, these differences are not large because the retention, effort, and ability sorting differences produced by variation in the separation pay eligibility criteria are offset by variation in active duty pay. The steady-state force and the average effort and average ability levels that are predicted to evolve with separation payments at all YOS beyond YOS 10 are shown in Tables 24 and 25, with costs in Table 26.

The cost of this system, $15.3 billion, is similar to the cost of the system that makes separation payments only at HYT points. Again, the system is cheaper than Current 1's $15.96 billion cost.

Table 24

Predicted Effects on Officers of Separation Pay/OAA System Coupled with a Graduated Active Duty Pay Raise (spm = .1; separation payments at all YOS above 10)

	Grade-by-YOS Distribution					
YOS	O-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	33.2	0.1	0.0	33.2	6	.589
5–10	26.3	3.3	0.0	29.7	10	.405
11–20	0.0	26.8	0.0	26.8	20	.253
21–30	0.0	6.2	4.0	10.3	30	.029
Total	59.5	36.4	4.0			

Manyears per accession = 10.41
Accessions based on force of 71,135 = 6,832
Average effort = 8.35
Average ability = –.15

NOTE: The graduated pay increases are (in percent): O-3 = 3 , O-4 = 4, O-5 = 5, O-6 = 6, and O-7 = 7.

Table 25

Predicted Effects on Enlisted Personnel of Separation Pay/OAA System Coupled with a Graduated Active Duty Pay Raise (spm = .1; separation payments at all YOS above 10)

	Grade-by-YOS Distribution					
YOS	E-1–O-3	O-4–O-5	O-6–O-7	Total	Survival to Start of YOS:	
1–4	31.3	21.1	0.0	52.4	5	.329
5–10	0.0	27.1	0.4	27.4	10	.187
11–20	0.0	11.3	6.6	17.9	20	.074
21–30	0.0	0.0	2.3	2.3	30	.004
Total	31.3	59.4	9.3			

Manyears per accession = 5.36
Accessions based on force of 647,187 = 120,734
Average effort = 3.86
Average ability = –.17

NOTE: The graduated pay increases (in percent): E-5 = 3.5, E-6 = 7.0, E-7 = 10.5, E-8 = 14.0, and E-9 = 17.5.

Table 26

Steady-State Costs of Separation Pay/OAA Retirement System (spm = .1; separation payments at all YOS; graduated pay raise)

	Current 1	With Pay Increase
Officer force of 71,135		
Annual payroll costs (billions)		
Basic pay	2.43	2.50
Retirement accrual	1.10	0.85
Total	3.53	3.35
Per capita accession costs (thousands)		
Basic pay	290.0	297.8
Retirement accrual	134.9	103.8
Enlisted force of 647,187		
Annual payroll costs (billions)		
Basic pay	9.48	9.80
Retirement accrual	2.95	2.14
Total	12.43	11.94
Per capita accession costs (thousands)		
Basic pay	68.6	71.0
Retirement accrual	21.6	15.8

Chapter Six

CONCLUSIONS

In this report, we summarize the theoretical model we developed in Asch and Warner (1994), present an empirical version of this model, and evaluate the current as well as alternative military retirement systems. The evaluation focuses on not only the force structure and cost implications of the current and alternative systems, but also their productivity implications. By productivity implications, we mean the capability of the systems to motivate individuals to work hard and effectively and to sort ability, i.e., to motivate higher-ability personnel to stay and seek advancement.

Our empirical model, which is based on the Gotz-McCall dynamic retention model, is capable of replicating the Army's enlisted and officer forces. Personnel enter the hypothetical forces and flow through the system based on historical (FYs 1987–1989) promotion rates. They make retention decisions at various YOS points based on tastes, random shocks, personnel policies such as HYT points, and internal (military) and external (civilian) pay levels. The model is calibrated so as to predict as accurately as possible the Army's actual FYs 1987–1989 grade-by-YOS distribution. In fact, compared with existing military retention models (e.g., ACOL), the model is unique in its ability to "endogenously" explain the observed force structure. It was demonstrated that the model predicts the observed force quite well and, furthermore, that the responsiveness of retention to changes in pay is consistent with estimates from econometric studies of retention. These observations, coupled with the model's theoretical superiority, give us confidence that the model will yield better forecasts of the effects of alternative compensation structures than could be obtained with other models (e.g., ACOL). This is especially

true for compensation structures that radically alter the lifetime compensation profile.

We use the model to analyze the costs, productivity, and force structure effects of several past proposals that have been offered to improve the vesting features of the current military retirement system, as well as to analyze the effects of several plans of our own design. The 20-year military retirement system has long been criticized for its cost and the apparent unfairness of its late vesting. The analysis found that two past proposals that provide for earlier vesting are not cost-effective. The Senate Armed Services Committee proposal for Band-Aid vesting adds to costs but is unlikely to provide benefits either from changes in the behavior of personnel or from modifications to the services' force management practices. Earlier vesting obtained via a reduction in the YOS required for an immediate annuity from 20 to 15 has mixed force structure effects. It is estimated to improve enlisted retention and reduce accessions. But it has a perverse effect on the officer force—it reduces retention on net and raises officer accession requirements. Furthermore, intergrade ability differentials fall for the most part, implying that the earlier-vested system does not sort ability as well. In addition, it adds about $1 billion per year to total force costs, and the average effort supplied by personnel generally falls. While lowering from 20 to 15 the YOS required for receipt of an immediate annuity may be a useful policy during the drawdown period, it is unlikely to be a viable policy in the post-drawdown environment.

Finally, we constructed several systems that vest earlier but do away with the immediate annuities for YOS 20+ separatees. These systems provide an OAA and a cash separation payment to those who separate after some minimum period of service. The OAA is intended to be the basic retirement entitlement to all personnel who complete the minimum service period. Our theoretical analysis suggests that the minimum service period should not be too low; in our policy analysis, it is taken to be 10 years. The cash separation payment becomes the force management tool in this retirement system. We envision that the payment level and payment eligibility criteria would be manipulated as needed to control personnel flows and the grade-by-experience distribution of the force. This system provides much more management flexibility than the current one-shoe-fits-all system. Under this system the services could make the separation pay-

ments available earlier in skills requiring youth and vigor than in skills in which there is a higher payoff to experience. (The services might also want to make larger separation payments to personnel whose military skills are not easily transferable to the civilian sector.) The availability of a system that would permit personnel to be separated on more generous terms prior to YOS 20 reduces the services' incentives to pad their stated personnel requirements. Our proposed system provides the tools to retain personnel longer in skills where even a 20-year career is too short.

Unless the cash separation payments are made very large, our simulation analysis indicates that an active duty pay raise would be required to sustain a capable military force. Under unfavorable assumptions (e.g., a low personal discount rate) several variants of our proposed system would add to costs. But, under the most likely set of assumptions, our proposed system would cost about the same or less than the current system. The active duty pay raise that our system requires would also permit greater skewing of the active duty pay table, which we show increases average effort supply and the incentives of high-ability personnel to stay and to seek higher-ranked positions. Thus, under reasonable assumptions, our proposed system is estimated to maintain the current force structure, add management flexibility, improve productivity, and maintain and possibly reduce compensation costs.

Appendix

METHOD USED TO CALCULATE RETIREMENT ACCRUAL CHARGE

Let $m_{i,t}$ denote the current pay that the military establishes for an individual in grade i at period t and $w_{i,t}$ be the proportion of those in period t who are in grade i such that

$$\sum_i w_{i,t} = 1 .$$

Based on the grade distribution at each period of service, the mean pay in year t is

$$m_t = \sum_i w_{i,t} m_{i,t} .$$

We also assume that those who separate from the military in grade i after period t receive the stream of retired pay $r_{i,t,j}$ with $j = t+1, \ldots, D$ (D denotes death period). We let $R_{i,t}$ denote the expected present value to the firm of retired pay of a loss from grade i at the end of period t, and $l_{i,t}$ denote the fraction of losses in period t who are in grade i such that

$$\sum_i l_{i,t} = 1 .$$

Then

$$R_t = \sum_i l_{i,t} R_{i,t}$$

is the mean expected present value of the retirement liabilities to the losses at period t. We also let sv_t be the survival rate into period t (i.e., the fraction of those surviving until the end of period $t-1$ who also stay for period t). If we define the military's per capita budget constraint, B^*, as the present value of compensation that DoD expects to pay to a new recruit, then:

$$\begin{aligned} B^* &= m_1 + sv_2 \frac{m_2}{(1+r)} + sv_3 \frac{m_3}{(1+r)^2} + sv_4 \frac{m_4}{(1+r)^3} + (1 - sv_2)\frac{R_1}{(1+r)} \\ &\quad + (sv_2 - sv_3)\frac{R_2}{(1+r)^2} + \\ &\quad (sv_3 - sv_4)\frac{R_3}{(1+r)^3} + sv_4 \frac{R_4}{(1+r)^4} \\ &= M^* + R^* , \end{aligned}$$

where r is the government discount rate, M^* is the expected present value at hire of future "wage" payments, and R^* is the expected present value of the new recruit's retirement liability.[1] (Note that the government may discount future dollars at a different rate than service members). The total pay budget is $N_1 B^*$.

We define the per capita accrual cost of retirement as the amount, A, that DoD must invest each year to fund the accumulating retirement liability of a new recruit. That is, A is an amount such that:

$$B^* = \sum_{t=1}^{4} sv_t \frac{(m_t + A)}{(1+r)^{t-1}} \quad \text{or} \quad R^* = \sum_{t=1}^{4} \frac{sv_t A}{(1+r)^{t-1}} \quad .$$

Using the relations above, the per capita accrual cost is:

[1]For simplicity, we assume that active service wage payments are made at the beginning of each period.

$$A = \frac{\sum_{t=1}^{4} (sv_t - sv_{t-1})\, R_t/(1+r)^t}{\sum_{t=1}^{4} sv_t/(1+r)^{t-1}} = \frac{R^*}{\sum_{t=1}^{4} sv_t/(1+r)^{t-1}},$$

where sv_t is the probability that a new entrant will remain until period t and $sv_t - sv_{t-1}$ is the probability that the entrant will quit at exactly period t.

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